THE NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, State Geologist

ECONOMIC PAPER No. 49

THE MINING INDUSTRY

IN

NORTH CAROLINA DURING 1913-17, INCLUSIVE

BY

JOSEPH HYDE PRATT, State Geologist

AND

MISS H. M. BERRY, Secretary and Statistician

RALEIGH
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GEOLOGICAL BOARD

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LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., January 1, 1919.

To His Excellency, HON. T. W. BICKETT,
Governor of North Carolina.

SIR:—I have the honor to submit herewith, for publication as Economic Paper No. 49, a report on the Mining Industry of North Carolina, for the years 1913–17, inclusive. In the collection of the statistics for this report, we carried out the arrangement of coöperation with the United States Geological Survey, as authorized by the State Geological Board.

Yours respectfully,

JOSEPH HYDE PRATT,
State Geologist.

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PREFACE

In the following report on the Mining Industry of North Carolina for the years 1913–1917, the Survey has tried to give a concise and accurate idea in regard to the production of the various minerals in the State, and their economic importance. In this connection there are published, in addition to the general information obtained by this Department, several descriptions of the occurrence of certain minerals, that have been prepared and published by men connected with the United States Geological Survey and the United States Bureau of Mines. Although these special reports have been printed in the United States Government publications, it has been thought best to reproduce them in this report, as they are of very great interest to the mining industry of North Carolina, and it was felt that they should be published in such shape as to become available to those interested in the mineral production of this State.

In the absence of the State Geologist, who has been granted a year's leave for military service overseas, this report has been compiled by Miss H. M. Berry, Secretary and Statistician of the Survey. One of the important parts of the report is collecting and tabulating all the statistics regarding mineral production, these being collected in coöperation with the United States Geological Survey. Individual statistics are considered confidential, except in those cases where special permission has been obtained from the producer for their publication separately.

JOSEPH HYDE PRATT,
State Geologist.

MINING INDUSTRY IN NORTH CAROLINA DURING 1913-1917 INCLUSIVE

BY JOSEPH HYDE PRATT, STATE GEOLOGIST
AND MISS H. M. BERRY, SECRETARY

INTRODUCTION*

During the years covered by this report, 1913–1917 inclusive, with the exception of 1915, there has been a steady increase in the total value of the State's mineral production. The decrease in 1915 was due to the general business disarrangement and confusion resulting upon the outbreak of the war in the middle of 1914. In 1916, however, the mineral production increased in value tremendously over that of any preceding year, and in 1917, reached a total of $5,411,452.

There is given in the table below the total value of the mineral production in the State since statistics were first collected in 1900. These figures show a steady increase in the development of the mineral industry of North Carolina.

VALUE OF TOTAL MINERAL PRODUCTION IN NORTH CAROLINA FROM 1900 TO 1917.

Year	Total Value of Mineral Production
1900	$ 1,604,078
1901	1,779,109
1902	2,003,077
1903	1,902,485
1904	1,985,675
1905	2,439,381
1906	3,007,601
1907	3,173,722
1908	2,307,116
1909	2,873,826
1910	2,848,446
1911	2,933,878
1912	3,514,892
1913	3,879,340
1914	3,692,461
1915	3,584,725
1916	4,746,674
1917	5,411,452

*The statistics given in this report, with the exception of gold and silver, copper, lead and zinc, were collected in coöperation with the United States Geological Survey.

In the following table is given a list of the minerals produced in the State and the value of their production during 1912–1917, inclusive.

MINERAL PRODUCTION IN NORTH CAROLINA FROM 1912—1917, INCLUSIVE.

	1912	1913	1914	1915	1916	1917
Stone:						
Granite	983,615	$ 1,116,475	$ 1,286,345	$ 1,246,810	$ 1,798,087	$1,506,541
Sandstone	6,450	3,500	11,172	191,888	52,321	228,048
Marble and other limestones	100,776	140,364	154,888		176,164	213,950
Clay and Clay Products:						
Brick and tile	1,456,703	1,600,723	1,447,994	1,078,541	1,541,576	1,654,832
Pottery	8,950	13,683	12,796	11,394	9,860	7,475
Pottery Clay and kaolin	139,821	139,644	164,837	143,696	151,823	182,176
Mica:						
Sheet	219,874	230,674	171,370	266,650	380,700	543,207
Scrap	36,675	37,239	23,900	33,943	41,880	34,134
Sand and gravel	38,487	127,574	72,989	124,697	150,209	231,813
Gold	166,014	126,448	131,141	173,001	26,237	12,287
Silver	2,985	1,095	844	743	436	915
Copper	10,521	0	2,718	3,005	2,411	34,123
Lead and zinc	25,694	1,142	0	0	0	222
Iron	186,264	211,791	100,917	116,472	249,948	445,898
Manganese	—	—	—	—	—	*
Feldspar	*	*	*	*	77,446	131,442
Talc and soapstone	63,304	48,817	28,413	21,501	41,824	41,766
Mineral waters	22,385	23,877	21,964	18,745	19,010	15,664
Abrasives:						
Corundum and emery						67,461
Millstones	10,625	14,772	5,164	12,002	14,489	—
Garnet						2,875
Chromite*	—	—	—	—	—	*
Barytes	*	*	*	*	*	5,080
Quartz	*	*	*	*	*	*
Graphite	—	—	—	—	*	—
Precious Stones	5,655	849	3,070	464	343	75
Tin	*	—	—	—	—	—
Monazite	—	—	—	—	*	3,806
Zircon	*	—	—	—	—	—
Miscellaneous	a30,104	b40,673	c51,939	d141,173	e11,910	f47,662
Totals	3,514,892	3,879,340	3,692,461	3,584,725	4,746,674	5,411,452

*Included under "Miscellaneous."
aIncludes quartz, barytes, feldspar, tin, and coal, and ores of rare metals.
bIncludes a small quantity of feldspar.
cIncludes barytes, feldspar, and quartz.
dIncludes barytes, feldspar, quartz, and monazite.
eIncludes barytes, quartz, monazite, and graphite.
fIncludes quartz, chromite, manganese, and precious stones.

A review of the above table shows that there has been a steady increase in the value of the stone production during these years, this being due largely to the almost continuous growth of the granite industry. In 1917 there was a slight decrease in the production of granite, but this was more than offset by the large increase in the production of sandstone and limestone over the production of previous years.

For a number of years clay products formed the most valuable of our mineral industries and in the total value stood at the head of the column until 1915, when the value of stone production came first in the order of production of the mineral products of the State. By far the largest part of the clay production was due to the manufacture of common brick.

Third among the mineral products of the State is mica, for which there is a large and increasing demand. During this period of five years there was a steady increase in the value of the mica output, with the exception of 1914, and in 1917, the total production of sheet and scrap mica was $577,341, which is the largest production yet recorded in the State. North Carolina is the largest mica producing State in the country, our mica being known as "standard mica," and considered the best grade mica on the market.

There has been a fluctuation in the values of the production of gold and silver during the past five years, the largest production being made in 1915, and the smallest in 1917. This variation is due to many causes, which are discussed under the head of "Gold and Silver" beyond.

The production of copper in 1912 amounted to $10,521, and then dwindled to nothing in 1914, and less than $3,000 during the next three years. In 1917, however, there was renewed interest in copper mining and the production came up to $34,123.

The most important metallic mineral produced during this period, however, has been iron, although there has been some fluctuation in the total value of its production—there being a decrease in 1914 and 1915 as compared with 1913 and a very much increased production in 1916; while in 1917 the production was almost double that of any previous year, amounting to $445,898.

One of the minerals whose development is comparatively recent in North Carolina is feldspar. The production for 1912, 1913, 1914 and 1915 cannot be given, as there were less than three producers during these years; but in 1916 the producers increased to seven and the production amounted to $77,446. This was nearly doubled in 1917 when the production amounted to $131,442.

Of the metallic minerals it will be interesting to know that productions of chromite and manganese were made during 1917, this being the first time these minerals have been produced in the State for many years.

Of the nonmetallic minerals which are again being produced in North Carolina, corundum and emery are the more notable.

There was a small production of monazite during 1916 and 1917, after several years of nonproduction. The amount produced, however, was very small as compared to the productions of former years.

Other minerals produced in the State during these years are sand and gravel, lead and zinc, talc and soapstone, mineral waters, barytes, quartz, graphite, precious stones, tin and zircon.

The following minerals showed a production in 1917, for the first time, or after a long period of cessation: corundum and emery, chromite, monazite, manganese, and lead and zinc.

The large increase in the mineral production in North Carolina during 1917 is undoubtedly due to the stimulating of all mineral industries because of war necessities; and, because of the demand for raw materials incident upon the period of reconstruction, there will undoubtedly continue to be an increase in the value of the mineral production during succeeding years.

There is given below a list of "Useful Minerals of North Carolina," with their localities, as taken from a bulletin of the United States Geological Survey, and which will be of interest to those studying the mineral industry of North Carolina.

USEFUL MINERALS OF NORTH CAROLINA*

Abrasive. See Corundum, Garnet, Millstone, and Novaculite.

Agalmatolite (pyrophyllite). In Algonkian rocks in a range, crossing Chatham and Moore counties. Worked for use in making wall paper and soaps and in foundries.

Agate. Carrabus County, near Concord and Harrisburg. Mecklenburg County, in small quantity. Orange County, moss agate near Hillsboro.

Allanite. Occurs in Henderson County, at zircon mines near Zirconia. Iredell County, abundant near Bethany Church. Madison County at Democrat. Mitchell County, Wiseman mica mine.

Almandite. See Garnet.

Amethyst. Iredell County at several localities southeast of Statesville. Lincoln County, at Lincolnton, near Ironton Station and Denver. Macon County, in veins cutting gneiss at several places in valley of Tessentee Creek near Scaly Mountain and south of Highlands. Wake County, near Raleigh. Warren County, near Inez, 10 miles south of Warrenton.

Aquamarine. Alexander County, mined at Hiddenite and Ellis mines, near Hiddenite. Burke County, has been found in South Mountain. Jackson County, mined several miles south of Cashiers. Macon County, mined at head of Tessentee Creek. Mitchell County, mined at Wiseman and other mica mines. Yancey County, in Ray and other mica mines.

Arsenopyrite (mispickel). Cleveland County, mined for gold at Kings Mountain mine. Occurs also in gold mines in Cabarrus, Gaston, Union, and Watauga counties, but only sparingly with other ores.

*Taken from Bulletin 624 of the United States Geological Survey on "Useful Minerals of the United States, 1917," by Frank C. Schrader, Ralph W. Stone and Samuel Sanford.

Asbestos. Burke County, occurs near Brindletown and Warlicks Mills. Caldwell County, near Baker mine. Jackson County, southern part; fine and fibrous. Macon County, Nantahala River. Mitchell County, near Bakersville. Wilkes County, near Wilkesboro and Brushy Mountains. Occurs in many other localities.

Auerlite. Henderson County, at zircon mine, in pegmatite, 2 miles west of Zirconia.

Azurite (blue carbonate of copper). At copper mines in Cabarrus, Chatham, Gaston, Granville, Mecklenburg, and Moore counties in small quantity.

Barite. Principal deposits are: Gaston County, about 5 miles south from Bessemer City and in a belt extending southwest parallel with Kings Mountain Ridge. Madison County, near Hot Springs, Marshall, Sandy Bottom, and Stackhouse. Has also been mined in Orange County at Hillsboro.

Beryl. Alexander County, mined at Hiddenite-Emerald mine. Burke County, near Burkmont, in South Mountains. In mica mines in Alexander, Iredell, Mitchell, and Yancey counties. See also Aquamarine.

Bornite (purple copper ore). Cabarrus, Rowan, and Stanly counties, chalcocite in Gold Hill district. Granville and Person counties, important ore in quartz gangue in Virgilina district. Occurs also in Alleghany County, Peach Bottom mine. Ashe County, Gap Creek mine. Chatham County, Clegg's mine. Guilford County, Gardiner Hill mine.

Brown iron ore (limonite, bog iron ore). Many deposits in eastern part of State in Duplin, Jones, Nash, New Hanover, Pender, and other counties.

Brown iron ore (brown hematite). Ashe County has been mined in upper part of Ore Knob copper mines, accompanying copper lodes. Burke County, many beds in a northeasterly direction from Jacobi Fork of Catawba River to Brushy Mountains in Wilkes County; large beds in Chatham County, at Ore Hill. Cherokee County, at Nottla, and along Valley River. Gaston County, Highshoals. Johnston County, near Smithfield. McDowell County, has been mined in Linville Mountains. Many localities have been worked in Buncombe, Burke, Caldwell, Catawba, Gaston, Lincoln, McDowell, Mitchell, Surry, Watauga, and other counties.

Cassiterite (*tin ore*). Tin belt extends from southeastern part of Cleveland County, through western part of Gaston County, to about 4 miles east of Lincolnton, Lincoln County. Cleveland County, has been mined at Jones, Foster, and Fairies mines, near Kings Mountain; and in Lincoln County, near Lincolnton.

Cement Material. Crystalline limestones in western part of State, and soft limestone in Eocene and Miocene, in eastern part of State, suitable for cement.

Cerium. See Allanite, Crytolite, Monazite, Polycrase, and Samarskite.

Cerusite (lead carbonate) Caldwell County, Baker mine. Cherokee County, Murphy. Davidson County, Silver Hill, with galena and silver ores. Rowan County, Gold Hill district.

Chalcanthite (blue vitriol, hydrous copper sulphate). Cleveland County, secondary mineral at Kings Mountain mine, mined for gold.

Chalcocite (copper glance). Cabarrus, Rowan, and Stanly counties, with bornite in Gold Hill district. Person and Granville counties, mined for copper in Virginlina district. Found also in Ashe County, at Ore Knob mine and Gap Creek mine. Cabarrus County, Pioneer Mills mine. Jackson County, Way Hutta and Wolf Creek mines. Swain County, Nichols.

Chalcopyrite. Ashe County, found in Ore Knob mine. Alleghany County, Peach Bottom mines. Chatham County, Clegg mine. In mines of Davidson, Gaston, Guilford, Mecklenburg, Rowan, and Union counties. Guilford County, Gardiner Hill mine. Haywood and Jackson counties, has been mined in Way Hutta, Cullowhee, Savannah, and other mines in copper belt. Lincoln County, Macpelah Church. Orange County, near Hillsboro and Chapel Hill. Wake County, near Raleigh. Watauga County, Elk Knob and Gap Creek mines.

Chalcopyrite (auriferous). Rowan County, Gold Hill district, principal copper ore.

Chromite. Buncombe County, near Democrat and Stocksville. Jackson County, at many places in vicinity of Webster, between Willets and Balsam Gap. Yancey County, in vicinity of Burnsville, has been mined and shipped from Mine Hill.

Chromium.—See Chromite.

Chrysocolla (silicate of copper). Found in many copper mines in western part of State.

Clay. (brick). Common throughout the State. Bricks are made from local clay pits at one or more localities in each of 67 counties out of the 98 counties in the State. Product in 1914 valued at more than $1,000,000.

Clay. (fire). Semirefractory and siliceous clays mined for fire brick in Buncombe County at Emma. Cleveland County, Grover. Guilford County, Pomona.

Clay. (kaolin). Avery County. Gaston County, at Bessemer City (reported). Jackson County, at Sylva and near Webster, at Beta (reported). Macon County, near Franklin. Mitchell County, on Bear Creek, near Penland, at Spruce Pine. Swain County, at Almond and near Bryson City. Yancey County, Green Mountain. Occurs in decomposed pegmatite veins in Smoky Mountain region in western part of State.

Clay. (pottery). Mined in Alamance County, at Liberty. Buncombe County, at Luthers. Burke County, at Morganton. Catawba County. Gaston County, Mount Holly. Lincoln County, Henry and Lincolnton. Randolph County, at Seagrove and Whynot Academy; also mined in Chatham, Johnston, Moore, Union, and Wilkes counties.

Clay. (sewer pipe). Guilford County, at Pomona.

Coal. Dan River area, in Triassic rocks: Carbonaceous shale outcrops from Germanton, Stokes County, to Leaksville; Rockingham County; semianthracite was mined near Leaksville; beds too thin, irregular, and small in extent to be of value. Deep River area; Chatham and Moore Counties, in Triassic rocks; bituminous, 3 feet thick, was formerly mined at Cumnocks.

Columbite. Occasional pieces found in Mitchell County, at Wiseman and other mines near Spruce Pine. Yancey County, at Ray mine, and elsewhere.

Copper. See Azurite, Bornite, Chalcanthite, Chalcopyrite, Chrysocolla, Cuprite, Malachite, Melaconite, and Tetrahedrite.

Corundum. Alexander County, mined to limited extent at Acme mine, near Statesville. Clay County, in peridotite in Buck Creek, Herbert, and other mines. Jackson County, considerable quantity at Sapphire mine, abrasive. Macon County, in Corundum Hill mine, near Franklin, and in Mincey mine, 2 miles Northwest of Corundum Hill. Madison County, at the Carter mine, near Democrat. Transylvania County, good quality in peri-

dotite at Burnt Rock mine. Yancey County, with magnetite, menaccanite, and staurolite, near Burnsville.

Corundum. (emerald, oriental). Found sparingly in Clay County, at Cullakeenee mine, Buck Creek, near Elf. Macon County, Corundum Hill mine.

Corundum (emery). Guilford County, occurs at McChristian place, 7 miles south of Friendship. Macon County, has been mined at Fairview mine, near North Skeener Gap, for abrasive; mined sparingly at several places south of Franklin. Mitchell County, near Bakersville.

Corundum. (ruby). Mined in Jackson County, Montvale. Macon County, at Corundum Hill mine, Cullasaja, Caler Fork of Cowee Creek.

Corundum. (sapphire). Clay County, few found near Elf. Jackson County, Sapphire and Whitewater mines, near Sapphire. Macon County, Corundum Hill mine.

Cuprite. (red oxide of copper). Sparingly in copper mines of Alleghany, Ashe, Caldwell, Chatham, Guilford, Jackson, Swain, Lincoln, and Mecklenburg counties.

Cyanite. Mitchell County, summit of Yellow Mountain. Yancey County, green cyanite at north end of Black Mountains.

Cyrtolite. Henderson County, at Zirconia. Mitchell County, in pegmatites, near Spruce Pine.

Diamond. Ten authentic diamonds have been found in the State: Burke County, two at and near Brindletown Creek ford. Franklin County, two from Portis mine. Lincoln County, Cottage Home. McDowell County, headwaters of Muddy Creek and near Dysortville. Mecklenburg County, Todds Branch. Rutherford County, Twitty's mine.

Emerald. (beryl). Alexander County, Hiddenite mine, near Hiddenite. Cleveland County, Turner mine, 5 miles southwest of Shelby. Mitchell County, Crabtree Mountain. See also Corundum (emerald).

Feldspar. Mitchell County, quarried at Penland. Found in nearly all mica mines of Mitchell and Yancey counties.

Galena. Cabarrus County, McMakin and other mines. Cherokee County, with gold ores, Murphy. Cleveland County, mined for gold at Kings Mountain mine in southern part of county. Davidson County, has been found at Silver Hill, with blende, native silver, etc. Gaston County, with blende in Causler, Shuford, and Long Creek mines. Randolph County, Hoover and Boss mines. Rowan County, Gold Hill district, for gold and silver, Union mine and others. Union County, Long mine. Watauga County, Beech Mountain, several localities. Wilkes County, Flint Knob. Other localities in Alleghany, Burke, Caldwell, Chatham, Macon, Montgomery, Surry, Swain, and Union counties.

Garnet. Burke County, abrasive and gem formerly mined 8 miles southeast of Morganton, along Laurel Creek. Jackson County, abrasive, mined at Sugar Loaf Mountain, near Willets. Madison County, abrasive, mined at Marshall.

Garnet. (rhodolite and almandite). Macon County, obtained with corundum and ruby, near In Situ Hill, on Cowee Creek, and on Mason Branch, 5 miles north of Franklin.

Glauconite. See Marl.

Gneiss. Alexander County, ornamental stone at Rocky Face Mountain. Watauga County, Blowing Rock. Not quarried.

Gold. Gold has been produced in recent years in many localities. There were 12 placer mines and 9 deep mines operating in 1914. Production was valued at $131,141. Burke County, principal production from placers near Bridgewater and Brindletown. Cabarrus County, from reworking dump of old Phœnix mine; also Gorman, Saunders, McMakin, and Reed mines. Catawba County, Catawba and England mines. Cherokee County, Middle branch of Tathams Creek, near Andrews. Cleveland County, has been recovered as by-product in mining for monazite. Davidson County, several mines in Cid mining district. Franklin County, small amount produced at Portis mine. Gaston County, Kings Mountain and Burrell-Wells mines. Granville County, Blue Wing and Copper King mines. Jackson County, Cullowhee mine. Macon County, small amount from placer, near Flats. McDowell County, small amount from placer near Marion, Dysortville, and Vein Mountain. Mecklenburg County, Catawba River, dredge near Charlotte, and Surface Hill hydraulic mines. Montgomery County, Iola mine, near Candor, most important producer in State, 650-foot vertical shaft and 450-foot incline shaft; small production from Old Coggin, Uwharra (old Montgomery), Martha Washington, and Golconda mines. Moore County, small prospects near old Cagle mine. Nash County, small output from Mann-Arrington mine; gold ore found in several prospects near Nashville. Orange County, small yield from North State placer. Polk County, Double Branch mine has five shafts. Randolph County, Scarlett, Talbert, Ashboro, Redding, and Southern Homestake mines. Rowan County, mines in Gold Hill district make small yield, mainly from old dumps; the Steele placer near Cleveland was a producer. Rutherford County, Biggerstaff hydraulic mine near Golden, large producer. Union County, Bonnie Doon and other mines near Indian Trail. See also Nagyagite.

Granite. About 40 quarries operating in 1914 produced granite valued at $1,286,345, located in the following places: Buncombe County, near Asheville. Davie County, Lexington. Henderson County, Balfour. Mecklenburg County, near Charlotte. Polk County, Rockliff. Rockingham County, Ruffin. Rowan County, at Faith; large quarry at Salisbury. Surry County, Mount Airy, very large quarry. Vance County, Greystone. Wake County, near Raleigh. Warren County, 1 mile northwest of Wise siding. Wilson County, Elm City. Also in Anson, Gaston, and McDowell counties, and small quarries, to supply local demand, have been opened at many other places in western part of State.

Graphite. Amorphous, has been mined in Alexander County, at Taylorsville. Cleveland County, at Kings Mountain mine. Haywood County, Waynesville. McDowell County, Graphiteville. Wake County, Method, and in Yancey County. Impure beds in gneiss in Catawba, Cleveland, Gaston, Lincoln, and Rutherford counties; opened near Catawba, Catawba County.

Gummite. Mitchell County, Penland, Spruce Pine, and other places.

Halite. See Salt.

Hematite. Has been mined in Chatham County, Ore Hill. Gaston County, Ormond mine. Harnett County, Buckhorn mine.

Hiddenite. (spodumene). Alexander County, gems mined in veins in biotite gneiss at Hiddenite, associated with aquamarine and emerald.

Ilmenite. Caldwell County, was prospected north of Lenoir.

Iron. See Brown iron ore, Chromite, Hematite, Ilmenite, Magnetite, and Siderite.

Kaolin. See Clay (kaolin).

Lead. See Cerusite and Galena.

Lignite. (brown coal). Common in marl beds in the eastern counties. In Triassic rocks in Anson County, on Brown Creek. Granville County, on Tar River.

Limestone. Produced mainly for burning into lime, and for road metal. Quarries in Craven County, at Newbern; Henderson County, at Fletcher and Hendersonville; Transylvania County, Brevard. Has been quarried in Beaufort, Buncombe, Jones, and New Hanover counties. Other localities known in Cleveland, Gaston, Lincoln, and Stokes counties.

Limonite. See Brown iron ore.

Magnetite. (magnetic iron ore). Occurs in pre-Cambrian formations in central and western parts of State, at many localities. Mined for iron at Cranberry, Mitchell County. Has been mined in Ashe, Caldwell, Cleveland, Gaston, Stokes, Surry, and other counties.

Malachite. (green copper carbonate). Occurs in small quantity in copper mines in western part of State.

Manganese ore. Caldwell County, reported from west of Lenoir. Chatham County, manganiferous iron ore occurs at the Buckhorn iron mine. Cleveland County, small veins and replacements in schists in Kings Mountain region; belt extends northeast into Catawba and Lincoln counties. Surry County, north of Dobson, manganiferous garnet. See also Psilomelane and Pyrolusite.

Marble. Cherokee County, quarried at Murphy. Occurs also in McDowell, Mitchell, and Swain counties.

Marl. (calcareous). Occurs in limited patches in all the eastern counties throughout an area equal to one-fourth of State. Used locally in many places.

Marl. (greensand or glauconitic). Occurs in southeastern counties, from Neuse River to Cape Fear River.

Melaconite. (black oxide of copper). Occurs sparingly in copper mines in western part of State.

Menaccanite. See Ilmenite.

Mica. (muscovite). Deposits have been opened in 18 or more counties in the western part of State, where the production of mica is an important industry. Has been mined and prospected extensively; probably have been over 100 good producing mines. Ashe County, near Jefferson, Beaver Creek, and Elk Crossroads. Buncombe County, near Balsam Gap, Black Mountain, Montreat, along North Fork of Swannanoa River. Burke County, near Burkmont, in South Mountains. Cleveland County, in Indian Town region and near Casar; several miles northwest of Shelby, near Belwood. Gaston County, in northwestern part of county. Haywood County, in Allen Creek basin south of Waynesville, and in Balsam Mountains at head of Pigeon River. Jackson County, a large number of mines in a belt several miles wide, extending northeast across the county from Cowee Bald and Moss Knob, on the Cowee Mountain divide, to Balsam Gap and Richland Balsam Mountain; also near Sols Creek along Tuckasegee River, near Pinhook Gap, Wolf Mountain, and at several places in southeastern corner of county.

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Lincoln County, in belt along west side of county. Macon County, in a belt several miles wide, extending northeast across county, from Nantahala River over Wayah Mountain to Cowee Bald and Moss Knob, on the Cowee Mountain divide; also near Higdonville, Scaly, and Highlands. Mitchell County, large number of mines in region between Bakersville, Crabtree Creek, Blue Ridge Mountain, Lineback, and Cranberry; Spruce Pine central point to mica region. Rutherford County, Isinglass Hill, three and one-half miles north of Rutherfordton, and other localities. Stokes County, near Sandy Ridge. Transylvania County, Bee Tree Fork region and near Sapphire. Watauga County, north of Boone and 2 miles northwest of Elk Crossroads. Yancey County, many mines along South Toe River and westward across Black Mountains, near Burnsville and Green Mountain.

Millstone. Anson County, sandstone used as grindstones, during the Civil War. Madison County, quartzite on Laurel River, used for millstone. Moore County, Triassic conglomerates, used for millstone, McLennans Creek. Rowan County, made from granitic rock at Salisbury.

Monazite. Found in gravels in area of about 3,000 square miles. Produced from placers in Burke County, around Bridgewater, Brindletown, Connellys Springs, and Morganton. Cleveland County, Belwood, Casar, Lawndale, Carpenters Knob region, Mooresboro, and elsewhere. Gaston County, Cherryville. Iredell County, north of Statesville. Lincoln County, western part. Madison County, in masses up to 60 pounds in weight near Mars Hill. Rutherford County, Ellenboro, Oak Springs, Rutherfordton, and elsewhere. Also in Alexander and Catawba counties.

Nagyagite. Cleveland County, mined for gold at Kings Mountain mine.

Novaculite. (whetstone). Anson County, has been quarried near Wadesboro. Orange County, few miles west of Chapel Hill, quarried extensively. Person County, near Roxboro.

Peat. Abounds in the eastern part of State, particularly in the seaboard counties. Not used.

Pitchblende. See Uraninite.

Platinum. A belt of platinum-bearing rock is reported extending from Cedar Falls, N. C., to Danville, Va.

Polycrase. Henderson County, in gold washings with zircon, magnetite, etc., near Zirconia.

Psilomelane. Caldwell County, in gneissic rocks, near Lenoir. Chatham County, with iron ore at Buckhorn iron mine. Gaston County, in schist 1 mile southeast of Kings Creek.

Pyrite. Cleveland County, mined for gold at Kings Mountain mine. Gaston County, has been mined as sulphur ore 5 miles north of Bessemer City. Rowan County, mined for gold in Gold Hill district. Union County, at Colossus.

Pyrolusite. (black oxide of manganese). Chatham County, with iron ore at Buckhorn iron mine. Gaston County, in schist 1 mile southeast of Kings Creek, and elsewhere in small quantity.

Pyrophyllite. Moore County, produced by three mines at Glendon for use as talc.

Pyrrhotite. (magnetic Pyrites). Plentiful, generally with pyrite and chalcopyrite in copper deposits in Ashe, Jackson, Macon, and Swain counties. Cleveland County, mined for gold at Kings Mountain mine. Macon County, occurs in gravels of corundum mines.

Quartz. ("rock crystal," clear and smoky quartz in crystals). Found in many counties. Fine crystals have been obtained from Alexander, Ashe, Cleveland, and Iredell counties. Cherokee County, quarried near Ranger for flux in copper smelting and in blocks as filler for acid towers. Gaston County, mined at Oliver mine.

Radium. See Polycrase, Samarskite, Uraninite, and Uranophane.

Rhodolite. See Garnet.

Road metal. See Granite, Limestone, Sand and gravel, and Sandstone.

Ruby. See Corundum.

Rutile. Clay County, in placer on Shooting Creek, east of Hayesville. Macon County, abundant with corundum in gravels of Mason Branch and Caler Fork of Cowee Creek. Fine specimens in Alexander and Iredell counties.

Salt. (brine). Rockingham, Chatham and Orange counties, formerly obtained from wells in Triassic beds.

Samarskite. (yttria ore). Mitchell County, large masses have been found at Wiseman mica mine; sparingly at other mica mines.

Sand and gravel. Dug at following places: Anson County, Lilesville. Buncombe County, Asheville. Cleveland County, Shelby. Gaston County, Bessemer City. Guilford County, Greensboro. Henderson County, Balfour. Iredell County, Statesville. Mecklenburg County, Charlotte. Moore County, West End. Wilkes County, North Wilkesboro.

Sandstone. Only quarry operating is at Sanford, Lee County. Idle quarries in sandstone of Triassic period in Anson County at Wadesboro. Chatham County, Chatham, near Egypt. Orange County, near Durham. Rockingham and Stokes counties, quarries in the Dan River belt.

Sapphire. See Corundum.

Serpentine. Very fine, dark-colored, takes fine polish. Buncombe County, Asheville. Caldwell County, Baker quarry. Clay County, Buck Creek. Also in Forsyth and Wake counties. Yellowish-green variety occurs in Caldwell, Orange, Stokes, Surry, Wake, Wilkes, and Yancey counties.

Siderite. (black band ore and ball ore). Chatham County, beds in Triassic rocks of Deep River opened at Egypt, Farmville, and Gulf. Occurs also in Davidson, Granville, and Halifax counties. Common as gangue material in gold mines, also at some copper mines.

Silver. Recovered in refining gold and copper, produced mainly in Person and Rowan counties. Native silver at Silver Hill and Silver Valley mine, Davidson County.

Soapstone. Many undeveloped masses in western part of State. Ashe County, probable valuable deposits 2 miles west of Beaver Creek, quarried for local use.

Sphalerite. (zinc blende). Cabarrus County, in McMakin mine with galena and silver ores. Cleveland County, mined for gold in Kings mountain mine in southeastern part of county. Davidson County, has been found at Silver Hill with galena and silver ores. McDowell County, in Dobson mine, Cedar Grove, in limestone. Rowan County, small quantity in Gold Hill district. Union County, Lemmon, Long Moore, and Stewart gold mines. Small quantities in Alleghany, Gaston, Macon, Madison, and Montgomery counties.

Spinel. Macon County, found in gravels in Cowee Valley. Mitchell County, gahnite variety in Chalk Mountain and other mica mines.

Spodumene. See Hiddenite.

Staurolite. Good single and double crossed crystals, have some commercial value as curios; found in Ashe County; Burke County, South Mountains; Cherokee County; Haywood County, near Waynesville; Iredell County, Belts Bridge; Macon County, near Corundum Hill; northern part of Wake County, and in many places west of Blue Ridge.

Sunstone. Iredell County, near Statesville.

Talc. Alleghany County, mined near Piney Creek. Cherokee County, was formerly mined at Tomotla. Jackson County, mined at Beta. Moore County, three mines at Glendon mining pyrophyllite. Swain County, mined at Hewitts.

Tetradymite. Burke, Cabarrus, Gaston, and McDowell counties, in minute scales at copper mines. Davidson County, occurs in Allen mine and in Beck's mine west of Silver Hill. Montgomery County, mined for gold at Asbury mine.

Tetrahedrite. Cabarrus County, has been found in McMakin mine with silver, zinc blende, and galena, and in Sudwick mine with copper pyrites. Cleveland County, mined for gold at Kings Mountain mine.

Thorium. See Aurelite and Monazite.

Tin. See Cassiterite.

Titanium. See Ilmenite and Rutile.

Tourmaline. Alexander County, black crystals at Stony Point. Yancey County, at Ray mine and many other localities.

Unakite. Madison County, in the Great Smoky Mountains of the Unaka Range in the slopes of the peaks known as The Bluff, Walnut Mountain, and Max Patch. Also in Yancey County.

Uraninite. (pitchblende). Mitchell County, in Flat Rock mine, in Deake mine, in a feldspar quarry near Penland, and in Wiseman mica mine.

Uranophane. Mitchell County, Penland, Spruce, Pine, and other places.

Xenotime. (yttrium phosphate). Burke County, from gold washings at Brindletown.

Yttrium. See Allanite, Cyrtolite, Polycrase, Samarskite, and Xenotime.

Zinc. See Sphalerite.

Zircon. Burke, McDowell, and Rutherford counties, in gravels of monazite mines. Henderson County, mined near Zirconia. Iredell County, occurs near New Sterling.

GOLD AND SILVER

During the five years covered by this report, 1913 to 1917, inclusive, the production of gold and silver has reached the highest and lowest points of any year since 1887, the maximum production being in 1915, when the total production was $173,744; and the lowest production in 1917, when it had dropped to $13,102.

North Carolina furnished in 1913 the greater portion of the gold output of the Eastern States. In that year there were 17 placer mines in operation which produced 308.53 fine ounces of gold; 7 deep mines and prospects produced 5,808.39 fine ounces of gold; 1,777 ounces of silver, and 20,400 pounds of zinc. There were 11,186 short tons of siliceous gold ores treated in North Carolina in 1913, with an average

precious metal recovery of $10.83 per ton, against 14,358 tons, with an average recovery of $10.62 in 1912.

The mine production in 1914 was 6,343.94 fine ounces of gold, valued at $131,141; 1,524 fine ounces of silver, valued at $843. North Carolina furnished in 1914 the greater part of the gold output of the Eastern States. Of the total production during this year, 12 placers produced 324.45 fine ounces of gold, and 9 deep mines and prospects produced 6,012.91 fine ounces of gold; 1,467 ounces of silver, and 20,434 pounds of copper. There were 19,441 short tons of siliceous gold ores treated in North Carolina in 1914, having an average precious metal recovery of $6.43 a ton.

During 1915 there was produced in the State 8,320.55 ounces of gold and 1,465 ounces of silver. Of the gold, about 95 per cent was obtained from siliceous gold ores, and the remainder from placer deposits. Of the silver, about 97 per cent came from siliceous gold ores, and the balance from placers. The gold ores treated yielded an average of $6.65 a ton in precious metals.

The year 1916 marked the beginning of the decline in the production of precious metals in North Carolina. During this year there was produced 1,269.22 ounces of gold and 663 ounces of silver. Of the gold, about 70 per cent was obtained from siliceous gold ores and the remainder from placer deposits. Of the silver, about 90 per cent came from siliceous gold ores and the balance from the placers. The gold ores treated yielded an average of $4.90 a ton in precious metals. The large decrease in the production of gold in North Carolina during 1916 is due largely to the suspension of operations at the Uwarra and Martha Washington mines in Montgomery County.

The production of gold continued to decrease in 1917, when the amount of gold obtained was 589.55 ounces. There was an increase, however, in the production of silver which amounted to 1,110 ounces. Of the gold, about 67 per cent was obtained from siliceous gold ores and the remainder from placer deposits. Of the silver, about 97 per cent came from siliceous gold ores. The gold ores treated yielded an average of $5.00 a ton in precious metals.

The gold obtained from North Carolina is very fine, carrying but a very small amount of silver. Nearly all of the silver credited to North Carolina comes from copper ores. This accounts for the large percentage increase of the silver production in 1917, when there was an increased copper production.

There is given below a brief resumé by counties of the operations of the gold and silver mining industries for the years covered by this report.

Resumé by Counties

Anson County: There was a very small production of gold from Anson County during 1914, but nothing has been reported from this county since that time.

Burke County: There was a production of gold from the Brindletown placers, near Bridgewater, in Burke County, in 1913 and 1914. During 1915 there was also a production from the Pilot Mountain placers at the western end of the South Mountains, where placer gold was obtained by hydraulic and ground sluicing, the principal yield being from Brindle and Suttewhite creeks. There was a small amount of gold obtained from this same section in 1917.

Cabarrus County: There was a small production from the placer deposits of Cabarrus County during the whole five years covered by this report. In 1915 the output was mainly from the Klutz and Litaker mines, near Concord, and the Saunders mine, near Bost's Mills. In 1917 it was reported that new interests are investigating the Pioneer Mill mine of Cabarrus County. Captain Thomas G. Jones reports in 1917 that he is opening up a property 12 miles south of Concord, owned by Charles McDonald, of Charlotte. He reports a deep shaft down 70 feet. Their equipment consists of a 5-stamp mill, 5 plates, 1 Bartlett concentrating table, 15-H. P. boiler, and 10-H. P. engine, with shafts, pump, etc.

Caldwell County: The Niebelung prospect near Lenoir, in Caldwell County, made a small output of gold in 1913. The operations were by hydraulic washing and crushing in a 5-stamp mill. The deposits are described by the manager as "free-milling gold quartz stringers in slates." In 1914 there was a production from the McKenzie mine at Hartland. Here there is a 5-stamp mill in operation and the gold was recovered by surface washing. There were small productions in Caldwell during 1915, 1916, and 1917.

Catawba County: There was a small output of gold from the Wheeler-Edwards placer in Catawba County in 1913 and 1915, there being no report of productions for the other years.

Davidson County: The Ore Knob mine in Davidson County was worked during 1917. The slag and tailing dumps at the Silver Hill mine, Davidson County, were re-worked during the same year, though only small shipments were made, owing to car shortage.

Franklin County: It was reported in 1914 that preparations were being made to resume both hydraulic and deep mining at the Portis mine, near Essex, Franklin County. This mine was reopened in September, 1915, and considerable work was done by steam shovels, discharging in rolls, crushing to one-eighth inch; but the mine was shut down in 1916, after considerable prospecting and experimentation.

Gaston County: There was a nominal output of gold in Gaston County during 1913. In 1915 it was reported that the old Catawba mine south of Kings Mountain, Gaston County, was under development part of the year and produced a small output of gold and silver. One other property east of Kings Mountain also produced a little gold. The discovery of gold ore on the Sandsig farm, east of Kings Mountain, was prospected by several shafts and cuts in 1915. There was no production, however, reported from this county in the two succeeding years.

Guilford County: In 1913 it was reported that on the Dickens property, adjoining the old Fentress mine in Guilford County, a new shaft 70 feet deep, disclosing a considerable vein of quartz, carrying gold associated with pyrite, was sunk. In 1914 preparations were made to work the old Gardner Hill mine and dump near Greensboro, and the erection of a 10-stamp mill was begun. In 1914 it was reported that work on this property was confined to unwatering and cleaning out old shafts to the depth of 228 feet and sampling same.

Iredell County: A small output of gold was reported from small prospecting operations near Mooresville, Iredell County, in 1913. There was no further report from this county during succeeding years.

McDowell County: A small production of placer gold was reported from near Dysortville, McDowell County, in 1913, 1914 and 1917. The Valley Mining Company is operating this mine by hydraulic method. They have two cutting pumps capable of developing 150 pounds pressure on 1¼-inch nozzle with centrifugal for moving the earth.

Mecklenburg County: There was a small output of surface gold in Mecklenburg County during 1913, one nugget being found in a cotton field during picking season. In 1914 the Thornton Lead and Steel Company operated an approximately 5-ton smelter near Charlotte, on North Carolina ores and residues for a short period, and some copper matte was shipped. During these years some gold was obtained as a by-product by the Catawba Sand and Gravel Company's dredge on the Piedmont placer. The Rudisil Mine has not been operated for several years, and during 1917 the shaft hoist and all machinery on the property was destroyed by fire. There is quite a large ore dump on the property.

Montgomery County: This county has been for many years the largest gold producing county in the State, and a brief review of the status of the different mines will be of interest.

In 1913 some development work was reported on the old Carter mine which is said to have disclosed three veins with promising values in gold. The property is on Little River and a suitable dam site and favorable outlook for waterpower were reported. This mine has not become a producer, however, during the period of this report.

The well-known Iola or Candor mine, for several years the largest gold producer east of the Black Hills, made a somewhat decreased production in 1913, part of the output being from the reworkings of old tailings. There has been no further report of a production from this mine. The principal vein in this mine strikes N. 45° E. and dips N. 45° W. The ore bodies are reported to dip out of the Iola ground and into the Uwarra (Montgomery) territory on the northeast, and the Martha Washington ground on the southwest. The Golconda vein, striking parallel to the Iola and lying southeast of it, appears to cross the Iola ground, but has not been developed there. The Iola mine is opened by 5 shafts and extensive drifts to a depth of 650 feet and is equipped with a 50-ton mill and modern cyanide plant. The stamps, weighing 1,750 pounds each, are the heaviest used in the

United States. The equipment includes Dorr classifiers, tube mill, Parral agitators, and Kelly filters. The ore is both sulphide and oxidized. One statement of treatment costs gave $1.005 per ton for milling and $0.635 for cyaniding.

The Iola mine was sold in September, 1914, to the owners of the adjoining Martha Washington mine, into which, as stated, the Iola vein both strikes and dips.

No operations were reported at the Martha Washington mine in 1913 and 1914, but in 1915 this mine was a small producer. In 1916, however, work was reported as having been abandoned on this property.

The Uwarra (Old Montgomery) mine adjoins the Iola on the northeast and the workings are in an extension of the Iola vein. There are two shafts, one 400 feet deep to the northwest of the outcrop. The property is developed by 5,000 feet of drifts and was equipped in 1913 with a 50-ton fine-grinding and cyaniding plant, at a cost of $50,000. Crushing and grinding with any cyanide solution and mechanical agitation will be practiced. The mine was operated extensively during 1913, but the mill did not begin operation on the ore until the last day of the year. Both mine and mill were operated extensively during 1914 and made a good output. It was also operated in 1915; but for only a few months during 1916, in which year it was shut down. There was no production from this property during 1917.

The ownership of the Old Coggins mine has changed in recent years, and the property was actively and very successfully developed in 1913. The mine was opened in 1913 by an inclined shaft 268 feet deep and by about 1,000 feet of drifts and crosscuts. It was equipped with a 10-stamp amalgamation and concentrating plant erected in 1913 to replace the former plant destroyed by fire in 1912. The ore was crushed, stamped, amalgamized and concentrated. Free gold was recovered, the gold-bearing sulphide concentrates stored for shipping, and tailings were impounded for future treatment. The mill installed had 10 stamps of 1,050 pounds each and a daily capacity of 40 tons. Some work continued at this property during 1915, 1916 and 1917, but it was mostly development work.

The Sallie Coggins prospect was idle in 1913. The property was originally worked in a small way for its free gold ores, but it is understood that sulphides predominate. This property was operated in 1915, but there is no further report of operations since.

The Hooper Gold Mining Company in 1914 was developing a prospect near Fisher. Two shafts were sunk and a 5-stamp mill was built which was not producing in 1914. The only placer gold reported was by N. R. Stafford from bench gravels near Troy.

Apparently the Rich Cog, Steele and Reynolds mines were the only properties under development in Montgomery County during 1917.

Moore County: The El Oro Mining Company, Inc., of Hemp, Moore County, reported in 1917 that they were doing deep mining through two shafts, one inclined and one perpendicular, using drifts and overhead stopes. They had a steam hoist and skip for inclined shaft, steam hoist and pocket for perpendicular shaft, air compressor and air drills. It is stated that they are completing a 75-ton mill, using the amalgamation process for extracting the gold and silver content of the ore, after grinding to 40-mesh in a ball mill, concentrating and cyaniding the concentrates. At the time the report was made it was stated that they expected to be in operation and make their first production within 30 days.

Nash County: Considerable prospect work was reported from Nash County during 1915. The Braswell Mining Company, of Nashville, reported that they had sunk a shaft about 20 feet, but were not very much encouraged by what they had found. There has been no further report of developments in this county since that date.

Polk County: The Double Branch mine, 9 miles southeast of Landrom, South Carolina, was prospected during 1914, but no further development has been reported from this mine.

Randolph County: The Old Scarlet copper mine in Randolph County, near Asheboro, was under option to the Tenvanoca Copper Company in 1913. A surface mine plant, engine, boilers, compressors, and machine drills were installed. On July 1, 1917, this property was taken over by the Fisher and Corozva Brothers Company, of Baltimore, Md., under option lease. New equipment was added, including large ore bins, 60-ton unit smelter, one sorted for smelting higher grades and concentrating lower grades.

The Southern Homestake and other properties were idle during this time, but development in this and several other prospects was reported as in view during 1913.

Rowan County: The gold production of Rowan County in 1913 was due to small sluicing operations. The Gold Hill and Union copper mines at Gold Hill made no production in 1913, but were producers in 1914. The shaft at the Gold Hill mine was reported in 1914 as being 755 feet in depth and a 40-stamp amalgamating and concentrating mill with a capacity of 60 tons had been installed. This mine was in operation during the first half of 1915, chiefly on siliceous gold ores which carried a small amount of copper and which was saved by concentration. In August, 1915, it was reported that mining operations had ceased. The only gold obtained from this county since 1915 was from re-working the old dumps and a little from sluice operations.

Rutherford County: The Biggerstaff mine, near Golden, became an active producer of placer gold in 1913. In 1914 this was the largest yielder of placer gold in the State. In 1915 it was stated that hydraulic giants were used at this mine against an eleven-foot bank, of which approximately 9 feet is overburden. A 2-mile ditch supplies water under a head of 200 feet. The gold is saved in ground sluice and is not much waterworn. The Biggerstaff and Melton mines near Golden are owned by W. E. Sudlow and

were reported in 1916 as the largest producers of placer gold in the State, which reputation was maintained in 1917.

Stanly County: A little placer gold was recovered from deposits near New London, in Stanly County, during 1915, 1916, and 1917.

Union County: The Old Colossus or Howie mine, near Waxhaw, the principal mine in Union County, was actively developed for five months in 1913, and, it is reported, was opened by a 355-foot vertical shaft and a 100-foot adit. The property was equipped with a 50-ton all-sliming cyanide plant, in which continuous agitation and decantation were practiced. The ore is sulphide with siliceous gangue and is oxidized to a depth of 40 feet. In 1914 the greater portion of the gold production from this county came from this mine. The mill was operated intermittently in 1914 for about four months. In 1915 the Howie was also the largest producer in Union County. In November of 1915 a 300-ton cyanide plant was built at this mine. It uses the Dorr system, which is said to have made an excellent recovery for the siliceous gold ore. In 1916, however, fire destroyed the shaft house of the Howie mine, which was not repaired until December, 1916. This made it necessary to unwater the mine, construct concrete retaining walls and piers to support the permanent head frame, and on March 12, 1917, the secretary of the company reported that they had, at the time of writing, almost completed the wall. He states: "Our mill will start within the next six weeks on a 50-ton daily basis, and we resume mining operations this week, using a temporary head frame and sinking winze on the Bull Face ore body at the third level; and following on the ore chute at an incline. Development work will also be pushed, as well as the dragging of ore from other exposed ore bodies on each of the levels. The Bull Face ore, which runs from $40 up, will be shipped to smelter until we have installed concentrators."

The Wentz property, near Matthews, made a nominal output from prospect work in 1913. The Davis mine, owned by the Mint Hill Gold Mining Company of Matthews, R. F. D. 26, was leased to the Mogul Mining Company of 100 Broadway, New York, in 1916. They reported in 1916 the sinking of a 200-foot vertical shaft. They are using the Ingersol-Rand jack hammers and have installed a steam hoist and compressor, boilers, blacksmith shop, sinking pump, etc. In 1917 they report that work has been discontinued.

In 1916 Mr. J. L. Younts reports that the Black Mine at Indian Trail was being unwatered by Mr. E. L. Propst, of Charlotte. He stated that the main shaft is 175 feet long at a 120-foot depth. It was expected that the mine would go to work as soon as the water was out, but no report to this effect was received in 1917.

Yadkin County: Some underground development work was reported at the Gross and Dixon mine near Cana, Yadkin County, in 1914, and an air compressor and drills were added to the equipment, which includes a tube mill of 25 tons capacity.

The Uwarra Mill, Candor, N. C.*

BY PERCY E. BARBOUR, MINING ENGINEER

The Uwarra Mining Co. owns and is operating a gold mine about 2½ miles from Candor, Montgomery County, N. C., and has just completed and put in operation a modern fine grinding and cyaniding plant of 50 tons capacity, which has several interesting points of divergence from general practice. Not the least interesting feature of this property is its location in an agricultural, cotton and peach raising country. The points of technical difference are considered by the company to be strides forward in the practice of the treatment of gold ores; the extraction now obtained, which varies from 94 to 97 per cent, is mentioned here to anticipate any hasty criticism of the details to be given.

Ore Occurrence

The ore occurs in fissure veins in a hard greenish-black diabase, which latter has been much broken by jointing and along the zone of fissuring has attained a slaty cleavage so distinct as to give the name of slate to the country rock as a whole, which, however, is properly diabase.† There are two veins on the property, which in places are 6 feet wide, but which will average about 2 feet, and one of these has ore of commercial value developed by underground works for over 800 feet on the strike. The ore is a hard quartz, pearly gray in one vein and streaked with red in another, but in both cases hard and tough. The walls are in places well defined, but in others they are frozen to the vein and, either way, much slate is unavoidably broken down while stoping, so that hand sorting has to be resorted to both underground and on top. Of the rock as broken underground, 10 per cent is sorted out by the muckers and sent up as waste. Later on this will be left in the old stopes, but conditions prevent it at present.

The mine cars leave the cage at the landing station, about 8 feet above the collar of the shaft, and are trammed across a trestle 117 feet long to the crusher bin and are there dumped on to a flat grizzly with bars set 1½ in. apart. There are four ore pickers here who pick out 16 to 20 per cent more of the coarse slate, which goes into the waste pocket of this crusher bin. This bin was the stampmill bin in the former company's old Montgomery mill, and because of its perfect condition was removed and utilized in the new plant, though not exactly what would have been provided if a new one had been built; however, it serves the purpose very well.

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*_Engineering and Mining Journal_, October 24, 1914, page 729
†Private communication from Joseph Hyde Pratt, State Geologist, Chapel Hill, N. C.

Handling the Ore

The ore is drawn from this bin through a standard 24 x 24-in. single rack-and-pinion steel-plate gate and passes over an inclined grizzly with 1-in. opening to the crusher. The material through the grizzly drops directly to the loading hopper of the conveyor, to which also comes the product from the crusher, which is of the standard Blake type, size 15 x 9 in., set for 1¾-in. product. The jaw plates are of chrome steel.

This crusher is separately driven by a 7 x 10-in. Chandler & Taylor medium speed throttling engine, horizontal type, and the engine and crusher are housed together in a crusher building separate from the mill but connected with it by the conveyor structure.

From the crusher and last grizzly, all ore is carried by a 14-in. wide trough belt conveyor, 88-ft. centers, traveling on an incline of 20° and at a speed of 250 ft. per minute. This conveyor has a capacity much in excess of present needs, but was provided for future expected increase in tonnage from the mine. The belt is a four-ply S. A. special conveyor belt with ⅛-in. rubber cover on the carrying side.

This conveyor is driven from the main mill shafting and discharges the ore into a cylindrical steel ore bin, 12 ft. in diameter by 20 ft. high, which is the only ore bin of this type in the East. This bin is without top or bottom, but is reinforced around both top and bottom with angle irons. The bin is supported on a concrete foundation, which was made duodecagonal in shape, instead of circular, to save the cost of circular concrete forms, and with walls 12 in. thick and 6 ft. 6 in. high. It was intended to reinforce this wall with expended metal, but a long delay in its arrival made a substitute necessary and heavy hogwire fencing, secured from a local hardware store, was used in its stead with entire satisfaction. The inside of this duodecagonal foundation was filled with loose rock from the dump and a 2-in. layer of cement grout on top made the bottom of the bin. This bin is just outside of the main mill structure. The ore from this bin is drawn through a standard 18 x 24 in. rack-and-pinion gate and fed by a 16 x 6-in. plunger feeder with adjustable eccentrics to the crushing rolls.

Crushing Methods

We think this is the first modern all-sliming cyanide plant to use rolls exclusively for wet crushing between the rock breaker and tube mill. A great deal of study, of course, was given to the selection of these crushing units. I have long been of the opinion that the stamp was out of place for this particular kind of stage crushing, for various

reasons. To H. W. Dennison, of the Allis-Chalmers Manufacturing Co., who collaborated with me in the design of this plant belongs no little of the credit in the choice of these rolls. However, the adjoining mine, the Iola, owned by the Candor Mines Co., has been operating a mill[1] using 1,750-lb. stamps, the heaviest in this country. The use of heavy stamps in our mill would have been objectionable also because our only mill site was on the hanging wall of our vein, not far from the shaft; this was one more argument in favor of a rotary crusher. Various types were considered, but rolls were finally adopted, and while at this writing the mill has been in operation but 90 days, our judgment in the installation of rolls seems to have been fully justified.

Two sets of 24 x 10-in. Allis-Chalmers, style B rolls were installed and operate under real wet crushing conditions, five tons of solution to one of ore going through rolls. The roll shells are of low carbon steel. These rolls are not provided with automatic fleeting devices,[2] which were carefully considered but finally omitted.

Our first set of coarse rolls getting the product from the Blake crusher set at 1¾ in. naturally gets a very variably sized feed; the slate and slaty ore break into pieces, some of which may be 3 or 4 in. long and 2 or 3 in. wide, although only 1¾ in. thick. It is severe service to feed such material to rolls. However, some of our rock goes to the rolls thus, and we have little or no trouble from them now that the feeders, both mechanical and mortal, have been properly adjusted.

Quoting from Mr. Holthoff's article, "Without abrasion there can be no corrugating. Abrasion is due to two causes, first, if the material fed is coarser than the rolls can nip without slipping; second, if the roll faces are running differential." Some of our feed, on account of the cleavage of our rock, is probably too coarse from the above standpoint, and we expected corrugations, but at the end of 90 days we have only very slight corrugations on our coarse rolls; but on our fine rolls, where the feed is more uniform and none is too coarse, our roll shells are as smooth and straight as can be desired. In this connection it must also be considered that our labor supply is drawn from local circles and we are operating with men who never saw a set of rolls before. Considering this and the tough and abrasive character of our quartz ore, we consider this a satisfactory result and we expect to take these corrugations out by hand adjusting and by regulation of the feed without the necessity of machining the shell. We cannot tell yet what the steel

[1] Iola cyanide mill, by Percy E. Barbour, *Engineering and Mining Journal*, Sept. 14, 1912.

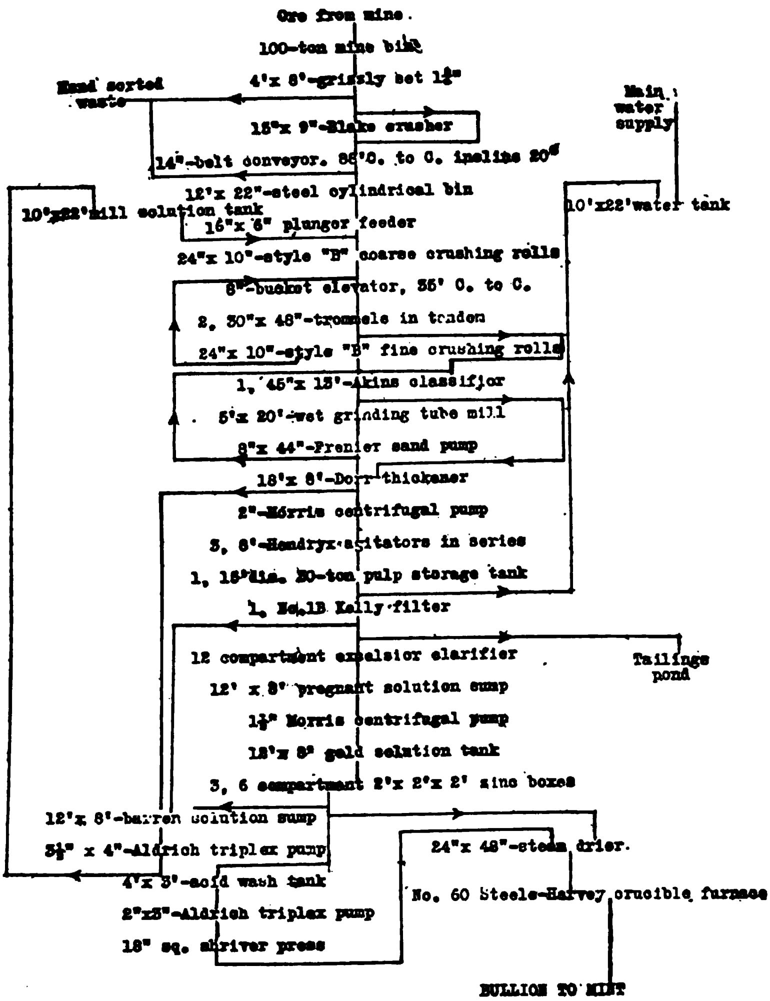
[2] Mr. Holthoff, in *Engineering and Mining Journal*, Vol. XCV, p. 1302, 1913, argues strongly against any fleeting device.

Mr. J. Parke Channing, in "Bull. 81" of the Mining and Metallurgical Society, states that the Miami has finally developed a fleeting device which fleets the roll once in 30 min., and by this slow movement entirely eliminates all the previous troubles had with various devices of this kind.

consumption will average per ton of ore, but present indications are that it will be satisfactorily low.

Screening and Classifying

The product from both sets of rolls is elevated by an 8-in. bucket, vertical-belt elevator, 35-ft. centers, which discharges it into a set of two 30 in. diameter by 48 in. long standard trommels set in tandem; the first screen of 3/16 metal has 1/2-in. round punched holes and the second of No. 10 steel is perforated with 3/16 round holes.[1]



Flow Sheet of Uwarra Mill

[1]This screen will be changed for one of woven wire, ¼-in. mesh, in order to get a coarser feed for and put more work on the tube mill.

All oversize is returned by launder to the coarse rolls. All the screen product goes to the fine rolls and the fine material through the last screen goes to an Akins classifier, 45 in. diameter by 13 ft. long. The choice of this classifier was influenced largely by the fact that it had so few bearings to care for, oil and maintain, compared to some others, and as for results accomplished, it has seemed to us that honors were pretty evenly divided. This classifier is giving satisfactory results as to classification and is giving a tube mill feed so dry that it is necessary to add solution.

The coarse sands from the classifier discharge directly into the feed box of the tube mill, which is of the gear-driven trunnion type, equipped with spiral feeder and reversed screw discharge. It is lined with Montana Tonopah iron bibbed lining. Danish flint pebbles are used.

The tube mill product is raised to the Akins classifier by an 8 x 44-in. standard Frenier pump, thus forming the usual closed circuit at this point in the flow sheet.

The overflow from the classifier goes to a Dorr thickener with steel tank 18 ft. diameter by 8 ft. deep, the overflow solution from which goes to a sump tank 12 ft. diameter by 8 ft. deep on the lowest bench of the mill, and is pumped back to the solution-storage tank, 10 ft. diameter by 22 ft. deep, located on the roll bench inside the mill building. For this service a 3½ x 4-in. Aldrich triplex pump, belt-driven, is used.

The thickened pulp from the Dorr is handled to the agitators by a 2-in. Morris centrifugal pump. We are considering the replacement of this pump by a Frenier because the abrasiveness of this ore is so great as to cause excessive wear on the rapidly revolving centrifugal and the latter cannot be operated satisfactorily on this small tonnage to give continuous flow to the agitators, which is necessary for continuous agitation.

The Agitators

There are three Hendryx 8-ft. diameter steel shell agitators, arranged for continuous agitation. This type of agitator was selected after an exhaustive series of tests in small agitators of the Hendryx type. A mechanical agitator was preferred to any other because it was desirable to eliminate the use of compressed air, first on account of certain local conditions and second on account of the cost of compressed air, not only considered *per se,* but also considered as to its compression in a steam-driven straight-line machine versus agitation by mechanical power from the Corliss engine of the mill. These tests, which I hope to publish later, demonstrate the efficacy of this type of agitator for these ores and the actual operation thus far bears out the result of the tests very closely. The agitation period is about eight hours to obtain

the extraction as given, varying from 94 to 97 per cent. These agitators have steam coils inside the tank and the pulp is kept heated to about 90° since our tests showed that this degree of heat was a decided advantage in accelerating extraction. The steam main from the boiler plant to the mill engine is a long one, and is carried in an insulated buried box on a considerable incline. The heating pipe for the agitators is taken off from this steam line in the engine room in such a way as to trap all the water of condensation in the line and we thus save much heat which would otherwise be lost. The power consumption of these three agitators, as shown by indicator cards, is 10.9 hp., which is certainly satisfactorily low.

The Filters

Owing to the fact that the filter works only during the day shift, a pulp storage tank between it and the agitators is necessary to hold the accumulation of the night shift mill run. This pulp storage tank is 17 ft. in diameter by 10 ft. high, with a conical bottom 9 ft. 6 in. high from the inverted apex of which the pulp is drawn to the filter. This pulp storage tank is provided with an overflow launder and a decantation device, which not only allows for sending a thick pulp to the filter, but also allows the removal immediately of a large amount of the pregnant solution without sending it through the filter.

The filter is a No. 1, type B, Kelly press, and it handles in one 12-hour shift the 50 tons of dry slime ground per day. The operation of this filter and the results have been quite unusual. The solution is expelled from the cake until it contains only 8 per cent moisture and the cake is then discharged as tailings without any washing whatever. The tailings as discharged, including both dissolved and unextracted values, often run as low as 20c. and for the current month will average about 36c. per ton of ore.

The pregnant solution from the filter goes to a 12-ft. diameter by 8 ft. gold sump tank and is then pumped by a 1½-in. Morris centrifugal pump through an 18-in. square-frame Shriver filter press for classifying, from which it goes into a 12-ft. diameter by 8-ft. gold tank, from which it flows by gravity to three 6-compartment zinc boxes, each compartment of which is 24 x 24 x 24 in., filled with zinc shavings, which are cut in the mill.

The barren solution flows to the 12 x 18-ft. sump tank previously mentioned. The precipitate is handled in a 4-ft. diameter by 3-ft. deep

cleanup tank, served by a 2 x 3-in. Aldrich triplex pump and the precipitate is then dried in a steel plate dry pan 24 in. wide by 40 in. long, heated by steam, and is finally smelted to bullion in a No. 60 Steele-Harvey tilting furnace fired by kerosene.

Every tank in the mill is of steel plate and besides those enumerated there is a water tank on the roll bench 10 ft. diameter by 22 ft. high a duplicate of the solution tank. The only use for water in the mill is for flushing the cake from the hopper of the filter to the tailing dump down the branch.

The circulating solution in the mill is 1.2 lb. KCN and the alkalinity about 2 lb. CaO per ton. No lead salts are used.

The mill is driven by its own engine of the Reliance-Corliss type, 12 x 36-in. stroke, running 150 r.p.m. with steam at 100-lb. at the throttle A Wheeler 300-sq. ft. surface condenser, with combined air and circulating pump under a grating in the engine-room floor, gives 25 to 27 in. vacuum and the engine with maximum mill load indicated 93.7 hp. The flywheel of this engine is 10 ft. in diameter, has a square cross-section and weighs 7,500 lbs. In the engine-room and driven from the main shaft by a friction clutch cutoff pulley is a 10-kw., 120-volt, direct-current generator, running at 1,150 r.p.m., which furnishes lights for the entire job—mill, surface, houses and underground stations. A model switchboard of black slate, 32 x 54 in., is furnished with a voltmeter and ammeter, ground detectors, rheostatt, main switch and eight current switches.

Details of Construction

The framing of the mill is of oak, not because oak had any special advantage, rather the other way, but because it was the only timber available. This was secured at prices ranging from $12 to $15 per thousand feet at the mills, and the hauling thence to the plant cost from $3 to $5, depending upon the mill from which it was hauled, the weather conditions, etc. The roofing was No. 24-gage galvanized corrugated and the siding was No. 26, and averaged in cost $3.70 per square. This light weight corrugated is plenty heavy enough for the favorable climatic conditions here.

All retaining walls and machinery foundations and mill floors were of concrete, mixed in the proportion of one of cement, three of sand and six of rock. Cement costs $2 per bbl., f.o.b. Candor. The rock was taken from the mine waste dump and the sand was secured nearby

at a sole cost of shoveling and hauling. The concrete was placed at $7.50 per yard and could have been put in at a less cost except for some adverse labor conditions obtaining at that time. A total of 336.3 yds. was poured as follows:

	Cubic Yards
Building and retaining walls	126.3
Steel ore bin foundation	11.0
Column pedestals	4.1
Tube mill foundation	13.6
Corliss engine foundation	35.5
Outboard bearing foundation	10.8
Condenser pit walls and floor	9.5
Condenser pier	0.6
Rolls foundation	8.9
Elevator pit walls and floor	7.7
Surface bottom of mill bin	0.2
Crusher foundation	5.1
Conveyor pit, walls, and floor	13.6
Crusher engine foundation	2.6
Line shaft pedestals	5.2
Generator foundation	1.2
Wheel pit mould	0.3
Crusher outboard bearing	0.7
Pedestals for storage tank	2.5
Agitator pedestals	7.3
Buckstay footings for new boilers	0.3
Kelly filter foundation	8.1
Thickener pedestals	4.3
Pump foundations	2.5
All floors, 4 in. thick	56.5

Cost of Mill

The total estimated cost of the mill was $45,000, and the mill was built complete for $42,796.48, distributed as follows:

Summary of Cost of Mill.

Concrete walls and foundation	$	1,962.12
Engineering		2,658.85
New boiler house addition		135.33
Foundation bolts and sundries		67.34
Boiler settings		637.92
Mill lumber and timber		1,237.07
Mill construction, sundry materials		1,627.86
Mill pipe line		1,067.51
Mill general expense		875.01
Mill labor		7,788.62
Mill excavation supplies		3.30
Freight on machinery		1,916.73
Machinery erection, superintendency		340.48
Mill wiring		4.09
	$	20,322.23
Machinery contract		22,893.00
Machinery sundries on open account		657.82
	$	43,873.05
Credit masons included in both items "Boiler setting" and "Labor"		144.90
Compressor foundation at $7.50 per yard		76.00
Compressor excavation		4.90
Compressor hauling		26.65
Compressor installing		71.54
	$	323.99
	$	43,549.06
Total credit from machinery contractor, account extras		752.58
Final total cost of mill	$	42,796.48

The distribution of the labor item in the above summary is given below:

Removing bin at old mill	$ 52.21
Building temporary stable	12.27
Moving dwellings from mill site	37.96
Building garage	20.25
Taking down part of old mill	53.16
Grading mill site	511.02
Grading boiler house site	44.21
Grading crusher house site	22.56
Foundations	974.13
Framing and erecting crusher bin	87.07
Framing and erecting crusher and conveyor plant	327.33
Framing and erecting main mill	1,116.68
Hauling lumber	290.32
Hauling corrugated, castings, pebbles, pipe, windows, etc.	31.20
Hauling brick for boiler setting	79.27
Hauling fire clay, sand, and lime for boiler setting	51.30
Hauling fixtures and stacks	24.58
Moving small boiler and stack	25.12
Hauling boilers, including unloading and placing	77.50
Connecting and raising stacks	28.47
Laying brick work of boiler settings	222.39
Connecting boilers	4.70
Building boiler house extension	65.02
Hauling mill machinery	298.58
Hauling new compressor	26.65
Installing compressor	71.54
Excavations for compressor	4.90
Repairing and raising dam at cooling pond	49.81
Building launder from condenser discharge to cooling pond, 500 ft.	152.33
Building ore trestle, shaft to crusher bin	102.93
Installing mill machinery	727.04
Erecting steel ore bin	32.14
Erecting agitators	101.68
Erecting mill tanks	808.23
Installing pond pump and supply tank	172.11
Main steam line	196.12
Mill piping	121.73
Wiring	9.49
General surface labor and teaming throughout period	612.03
Labor for contractors' account	142.59
Total	$ 7,788 62

Labor conditions were very unfavorable. In the first place the labor was inexperienced on construction, and secondly, it was composed more or less of farm hands. Laborers received $1.50 for 10 hours; carpenters, $2 to $3; mechanics, $2 to $2.50. All tank erection and riveting was done by men instructed here, who had never done any of this work before.

On a basis of a 300-day year and 50 tons per day, the mill cost $2.85 per ton of annual capacity.

Production

In the following table there is given the production of gold and silver by counties, 1913 to 1917, inclusive, which will illustrate the distribution of gold produced throughout the State:

PRODUCTION OF GOLD AND SILVER IN NORTH CAROLINA DURING 1913, 1914, 1915, 1916 AND 1917, BY COUNTIES.

County	1913			1914			1915			1916			1917		
	Gold	Silver	Total	Gold	Silver	Total	Gold	Silver	Total	Gold	Silver	Total	Gold	Silver	Total
Anson	$......	$......	$......	$ 15	$ 1	$ 16	$......	$......	$......	$......	$......	$......	$......	$......	$......
Ashe													187	25	212
Burke	1,200	5	1,205	725	3	728	300	2	302	100	25	125	500	40	540
Cabarrus	548		548	22		22	281	1	282	200	162	362	700	50	750
Caldwell	210	2	212	600	3	603	150	1	151	100		100	300	25	325
Catawba	250	1	251				553	2	555	300		300			
Davidson													1,200	600	1,800
Gaston	155		155				200	1	201						
Granville							7,341	51	7,392	2,000	10	2,010	100		100
Guilford							8,440	30	8,470	170	5	175	500	5	505
Iredell	210	1	211										100	5	105
McDowell	477	2	479	2,000	6	2,006							300		300
Mecklenburg	496	2	498	2,000	24	2,024	725	2	727	300		300	300		300
Montgomery	116,000	758	116,758	85,010	543	85,553	90,324	409	90,733	4,408	25	4,433	2,000	100	2,100
Randolph	2,194	300	2,494	50	1	51							800		800
Rowan	1,079	8	1,087	34,519	227	34,746	45,864	110	45,974	600	52	652			
Rutherford	629	5	634	3,091	6	3,097	5,694	13	6,707	5,820	2	5,822	1,500	25	1,525
Stanly				22		22	4,129	51	4,180	1,300	3	1,303	800	10	810
Union	3,000	11	3,011	3,087	30	3,117	8,000	70	8,070	10,939	152	11,091	3,000	30	3,030
Totals	126,448	1,095	127,543	131,141	844	131,985	172,001	743	173,744	26,237	436	26,673	12,287	915	13,202

The next table gives the value of the gold and silver produced in North Carolina from 1882 to 1917 inclusive:

GOLD AND SILVER PRODUCTION IN NORTH CAROLINA FROM 1882 TO 1917.*

Year	Gold	Silver	Total
1882	$ 190,000	$ 25,000	$ 215,000
1883	167,000	3,000	170,000
1884	157,000	3,500	160,500
1885	152,000	3,000	155,000
1886	175,000	3,000	178,000
1887	225,000	5,000	230,000
1888	136,000	3,500	139,500
1889	145,000	3,878	148,878
1890	118,500	7,757	126,257
1891	95,000	6,465	101,465
1892	78,560	12,671	91,231
1893	53,600	17,325	70,925
1894	46,594	455	47,049
1895	54,200	520	54,720
1896	44,300	646	44,946
1897	34,600	388	34,988
1898	84,000	905	84,905
1899	34,500	388	34,888
1900	44,653	15,986	60,639
1901	60,410	34,023	94,433
1902	93,650	30,212	123,862
1903	113,604	16,907	130,511
1904	123,924	19,133	143,057
1905	129,153	20,216	149,369
1906	122,008	30,944	152,952
1907	82,195	14,299	96,494
1908	97,495	668	98,163
1909	43,075	324	43,399
1910	68,586	4,888	73,474
1911	70,282	500	70,782
1912	166,014	2,985	168,999
1913	126,448	1,095	127,543
1914	131,141	843	131,984
1915	172,001	743	172,744
1916	26,237	436	26,673
1917	12,187	915	13,102

*Coining value.

Producers and Owners of Mines

The following is a list of companies and individuals who have been or are possible producers of gold and silver in North Carolina:

F. C. Abbott & Co., Charlotte, N. C. .... Grier Mine
Dr. Chas. L. Alexander, Charlotte, N. C. .... Yellow Dog Mine
James A. Butler, Statesville, N. C. .... Butler Mine
Rudisill Gold Mining Co., Charlotte, N. C. .... Rudisill Mine
Catawba Gold Mining Co., care Geo. R. Collins, Salisbury, N. C. .... Shuford Mine

The Consolidated Sales Mining, Milling and Mfg. Co.,
care M. Groenendyke, Charlotte, N. C.
A. M. Cox, Georgeville, N. C. .... Garmon Mine
Thos. J. Dolan, 112 N. Broad St., Philadelphia, Pa. ..... Argo Mine, Nash County
El Orox Mining Co., Hemp, N. C. .... Clegg Mine
Eureka Mining Co., High Point, N. C. .... Hoover Mine, Guilford County
Sedbury Mine, Montgomery County
J. W. Fleming, Lenoir, N. C., R. 5 .... Fleming Mine
Gross Dixon Mining Co., Cana, N. C., R. 2.
John A. Hodgin, Greensboro, N. C. .... Hill Mining Tract
Howie Mining Co., 763 Calvert Bldg., Baltimore, Md. .... Howie Mine
John F. Jones, Blacksburg, S. C. .... Jackson Mine
Martha Washington Mining Co., Candor, N. C.
A. C. Mauney, Salisbury, N. C. .... Rumpler Mine
Mogul Mining Co., Matthews, N. C., R. 26 .... Davis Mine
John J. Peters, Linwood, N. C., R. 2 .... Cross Mine
Pioneer Gold Mining Co., Concord, N. C. .... Pioneer Mine
W. S. Proctor, Candler, N. C.
Rich Cog Mining Co., Eldorado, N. C. .... Rich Cog Mine
T. A. M. Stevenson, 655 W. 4th St., Winston-Salem, N. C. .. Silver Hill Mine
W. E. Sudlow, Golden, N. C.
Surface Hill Mining & Milling Co., Charlotte, N. C.

COPPER

Copper mining in North Carolina ceased entirely in 1913, but there was a revival of it in 1914, with a small production from the Cullowhee mine in Jackson County. There was a small production in 1914 from the Blue Wing district; in 1915 there were productions from the Copper King district of Granville County, the Gardner Hill mine of Guilford County, and the Gold Hill district of Rowan County. In 1916 there was a small production of copper from the Virgilina district of Granville and Person counties and the Gold Hill district of Rowan County.

During 1913 operations were suspended on the Cullowhee copper mine, and matte furnaces near Webster, Jackson County. One car of slag and copper bottoms from the old Ore Knob mine in Ashe County was shipped by J. P. Labaw to the United States Metals Refining Company at Chrome, New Jersey. This car of 72,739 pounds contained the following:

Gold	12.904	ounces
Silver	112.11	ounces
Copper	14,672.	pounds

The copper produced in 1915 was derived from concentrates produced from 4,438 tons of ore mined in Granville, Guilford and Rowan counties, which yielded approximately 4 pounds of copper per ton of ore concentrated.

In 1916 the copper was derived from ore mined in Granville and Rowan counties which yielded approximately 59 pounds of copper per ton. The Ore Knob mine in Ashe County was under development in 1916 and it is said that a flotation plant to treat the copper ores would be installed.

The Copper King mine now being operated by the Tenvanoca Copper Company is situated in Person County, 3 miles south of Virgilina, Va. In 1917 it was reported that the property was taken over by Fisher and Corozza Brothers Company, of Baltimore, under option lease. They have added considerable equipment, including large ore bins, and are erecting a 60-ton unit smelter on the property.

It is reported that work was carried on during 1917 on the Durgy mine, Person County, located 8 miles south of Virgilina, Va., and formerly owned by the Person Consolidated Copper and Gold Mining Company. The main shaft has reached the 525-foot depth and levels cut out at 515 feet. Extensive work has been done on the 415 and 340-foot levels. The property is in running condition, and the underground works are being kept unwatered. Shrinkage method of stopage is being used. There has been installed a complete steam, air and electric equipment. It is expected that the property would be actively worked during 1918.

It is also reported that the Copper King mine in Person County, and Gardner Hill mine in Guilford County have been taken over by Baltimore interests and that a 50-ton smelter to handle the ores from all of these properties is being built at Virgilina, Va.

Production

In the table below there is given the production of copper ore and the amount and value of copper obtained from this for the years 1900 to 1917, inclusive:

PRODUCTION OF COPPER FROM 1900 TO 1917, INCLUSIVE.

Year	Crude Ore Mined	Copper Produced	Value
	Tons	*Pounds*	
1900	6,948	------------	$ 41,600
1901	10,398	512,666	76,900
1902	16,741	1,417,020	212,553
1903	4,106	458,133	67,037
1904	4,250	305,000	36,600
1905	10,000	488,888	88,000
1906	11,729	703,775	135,829
1907	11,011	597,878	116,416
1908	180	19,393	2,560
1909	3,575	224,512	29,186
1910	2,221	140,514	17,845
1911	------------	------------	------------
1912	500	63,766	10,521
1913	------------	------------	------------
1914	408	20,434	2,718
1915	4,438	17,170	3,005
1916	166	9,800	2,411
1917	1,249	124,991	34,123

Owners and Operators of Copper Properties in 1917

Eli Brady, Prosperity, Moore County, N. C.

Southern Minerals Co., Ore Knob, N. C.

Cullowhee Mining and Reduction Co., Cullowhee, N. C.

Gold Hill Consolidated Co., Gold Hill, N. C.

W. N. Kidd, Highfalls, N. C.

R. G. Lassiter, Virgilina, Va. (Person and Granville counties).

D. S. Lindsay, Judson, N. C., R. F. D.

S. Talbert McKinney, 18 Broadway, New York, N. Y., Gold Hill, N. C.

Fisher and Corozza Bros. Co., 416 Equitable Bldg., Baltimore, Md. (Person and Granville counties).

Sig. H. Rosenblatt, 18 Broadway, New York, N. Y., Gold Hill, N. C.

Watauga Copper Co., Eulalie, Macon County, N. C.

LEAD AND ZINC

The only lead and zinc deposits of importance in North Carolina are those in the Silver Hill or Cid district in Davidson County, which are described in Bulletin 22 of the publications of the North Carolina Geological and Economic Survey. The first ore mined was lead carbonate

containing disseminated plates of native silver. Sulphide ores were soon reached, and the later history of the mine is concerned largely with repeated dumps to handle the mixed sulphide or constituent of galena, sphalerite, chalcopyrite, and pyrite, and containing about 20 per cent lead, 40 per cent zinc, 0.5 per cent copper, 9 per cent iron, and some gold and silver. The total depth of the mine worked, as reported in 1915, is 725 feet on the vein ore 570 feet vertical. One car load of 40 per cent zinc concentrates, resulting from the work of earlier years, was shipped from this mine in January, 1913. There were no productions in 1914, 1915 and 1916; but in 1917 a small quantity of lead was marketed which came largely from the dumps of the Silver Hill mine.

Mr. T. A. M. Stevenson, of Winston-Salem, owner of the Silver Hill mine, reports that Mr. H. M. Baker is working the dump ore of this mine by a flotation process; that the Atlantic Ore and Alloy Company is working the slag dump, and that he (Mr. Stevenson) is prospecting with a core drill. No ore was shipped on account of the embargo.

"The Silver Valley mine, a few miles northeast of Silver Hill, has similar mixed sulphide ore. This mine was worked to a depth of 210 feet in the early eighties, but has had no recent output. Difficulties of concentration seem to have been the trouble at this mine. The successful work of mixed sulphide ores elsewhere and the recent opening of mines of zinc ore mixed with other sulphides in New York and Virginia, suggest the possibility that these mines in North Carolina may yet make important contributions to the zinc output of the United States."*

Production

There is given in the following table the production of lead and zinc in North Carolina from 1912 to 1917, inclusive:

PRODUCTION OF LEAD AND ZINC IN NORTH CAROLINA
1912—1917, INCLUSIVE.

Year	Lead—Pounds	Zinc—Pounds	Total Value
1912	92,000	283,320	$ 25,694
1913	----------	20,400	1,142
1914	----------	----------	----------
1915	----------	----------	----------
1916	----------	----------	----------
1917	2,583	----------	222

*C. E. Siebenthal, "Zinc and Cadmium in 1915" Min. Res. of U. S., 1915, Part I, page 871.

IRON

The iron ores of North Carolina are widely distributed throughout the State and include magnetite (the magnetic oxide of iron); hematite (the red oxide); limonite (the yellow oxide); and bog iron ores. Siderite or spathic iron occurs sparingly at a number of mines.

Up to the outbreak of the world war, the low prices of iron have made mining in a great many of the North Carolina localities unprofitable. As the demand for iron grew, however, in 1914 to 1917, a number of hematite deposits were opened in Madison and Cherokee counties which had not been worked for many years, and some of which had never been mined.

The history of iron mining in North Carolina dates back to as early as 1729, when small shipments of iron were made to England. Probably the first ore mined was the bog ores near the coast. Mining for iron almost kept pace with the settlement of the western portion of the State, and the remains of many of the old workings are still visible.

Some of the principal iron localities are: The magnetite ores of Granville, Stokes, Surry, Catawba, Ashe and Avery counties; the limonite ores of Chatham, Gaston, Madison and Cherokee counties; and the hematite ores of Granville County. Geologically, the magnetites and hematites are confined almost exclusively to the crystalline rocks. Some limonites are also found in these rocks, as well as in the Ocoee formation of Madison and Cherokee counties. Limonite ores (bog iron ores) are also found in the more recent formations of the Coastal Plain region.

The most noted iron mine in the State is the magnetite iron mine at Cranberry, Avery County, which has been worked continuously since 1876. This ore was first worked in a small way in Catalan forges as early as 1820, and the quality of the iron made soon became known and attracted a great deal of attention throughout the East. The ore body consists of an immense lens of magnetite which has associated with it hornblende, pyroxene, epidote, quartz, feldspar, calcite, garnet, zircon, allanite, serpentine, etc., in varying proportions. There is undoubtedly a large quantity of this type of ore in the Cranberry district, and the deposits are adapted to pig iron at a low cost.

Similar deposits of magnetic iron occur in Ashe County which were operated on a small scale as early as 1802. These deposits are located in the northeastern part of Ashe, principally along the north fork of the New River and its tributaries. These deposits are described in some detail in Economic Paper No. 34 of the North Carolina Geological and Economic Survey, pages 65-72.

BROWN HEMATITE (LIMONITE) ORES

The brown hematite (limonite) deposits of Cherokee County are among the most important in the State. The ores were worked in forges as far back as 1840 and supplied the surrounding country with bar iron for local uses. Since 1888, however, none of these forges have been in operation. Because of the great demand for iron brought about by the war, there was great activity in this iron region during 1917, and a number of companies and individuals are working these deposits in Cherokee County, principally in the vicinity of Andrews, Marble and Murphy.

Other valuable deposits of brown hematite are located at Wilson's Mills,* Johnston County; at Shut-In Creek, Madison County; and at Ore Hill, Chatham County.

In the summer of 1917, Mr. John E. Smith, Geologist of the Geological Department of the State University, made a brief survey of the brown hematite deposits of Madison and Cherokee counties, with the following results:

"*Madison County.* Mine owned by Anson G. Betts Company of Asheville, and is located about four miles southwest of Hot Springs, 1½ miles from mouth of Shut-In Creek. The plant is on the creek and the ore extends westward along the hillside to the summit about two miles distant. Ore occurs along and near the contact between a conglomerate and a limestone of Cambrian age, some of it being residual in the clay.

"The mines are one-half to 1 mile from the plant and were reached from it by two tramways. The ore was all worked from open cuts except the last attempt, in which the hydraulic process was used. This was about 300 yards from the plant and the water and ore were carried to the plant by means of an open box flume. The water was piped from up the creek to a tank at the plant by gravity and then pumped to supply a hydraulic stream at the mine.

"The equipment consists of three boilers; one centrifugal 6-inch pump; one 3-inch steam pump; one 2-inch steam pump; one steam locomotive, 28 tons; one gasoline locomotive, 3 tons; 20 dump cars of 1 yard capacity; and 1½ miles of track between the plant and the railroad. The concentration of the ore is accomplished by means of the log roller process, the ore being moved by gravity as it passes through the plant, capacity 125 to 300 tons daily.

"In all, there were six mines opened on this property, from which about 30,000 tons of ore have been taken, half of this by the Betts Company. At first the cost was $1.00 to $1.25 per ton, but later was reduced 25 per cent or more by careful management. Their dump cars have been removed to Cherokee County; also tracks, except that between the plant and railroad. Operation ceased July 15, 1917.

*See Economic Paper No. 8, "The Mining Industry in North Carolina during 1903," page 23.

"*Cherokee County.* Fain Iron Works, ¾ miles southwest of Murphy, were leased by Anson G. Betts Company. The vein is a brown iron ore extending N. 50° E., is nearly vertical—15 to 50 feet wide—averaging nearly 30 feet maximum depth; worked 50 feet; vein much deeper; has been proved for ½ mile. Ore is worked by blasting, with pick and shovel, and is carried by dump cars of 1½ tons capacity. It is moved by gravity along 2,200 feet of track (4 per cent grade) to L. & N. siding, ½ mile from Murphy. The empty cars are drawn back by mules. This ore is loaded without screening or washing and there is no waste in stripping on top.

"About 12 men were employed (summer 1917) at $1.85 per day and 500 to 600 tons per week were shipped to Middlesboro, Ky., and LaFollette, Tenn. This ore ranges from 44.75 to 49.5 per cent iron; is mined at a cost of 45c to 48c per ton; and sells for $2.60, f. o. b. cars at Murphy. The freight rate is about $1.00 per ton. Operations were begun here in April, 1917, and about 7,000 tons have been produced since that time.

"The Wells property is 2 miles east of Murphy and is owned by Anson G. Betts & Company. The vein is 3 to 8 feet wide; is nearly vertical, and is a solid black-brown ore, extending for ½ mile. Only the black ore was used, it being dug out of a low grade (35 per·cent) ocherous ore. This deposit was worked for about 2 months and closed July 1, 1917, after producing more than 1,000 tons.

"The Dockery place is 6 miles east of Murphy at Montvale. The ore vein here is made up of flat lenses stacked one on another and reaching a maximum of seven layers, width 1 to 8 feet; dip about 45°. This was worked for about 3 months and produced about 3,000 tons.

"The Kinsey property joins the Dockery place and the ore lies in the same formation. About 7,000 tons have been produced since the first opening of this mine some years ago, 1,200 of which was mined this year.

"The J. M. Kilkpatrick property (worked by Betts & Company) joins the Kinsey place on the east, 7 miles from Murphy. Here the vein is 20 feet wide, vertical and cut into two parts by a "horse." The ore is more solid than that on the Kinsey property and has been proved for nearly one-half mile. It has been traced through the property of Mr. Welch and J. Green for half a mile further. It has produced 1,000 tons recently.

"The Puett property at Marble, Cherokee County, joins the property of W. McHan on the south and is worked in connection with it by Betts & Company. The two have produced 1,200 to 1,500 tons during the last six months. Some carloads of this ore are reported to have produced 56 per cent iron. No screening or washing was done in concentrating the ore. The Company pays Mr. McHan a royalty of 10 per cent per ton.

"W. McHan at Marble, N. C., began in January, 1917, to mine brown iron ore. The work was done by contract until April, when he took charge of it himself. The ore was worked without screening or washing and averaged 45 per cent iron. It was sold at the rate of $3.00 for 50 per cent ore f. o. b. cars at LaFollette, Tennessee. Exclusive of hauling and loading on the cars, the cost was $1.35 per ton at the mine. About 900 tons were produced and work was discontinued about July 1, 1917. One car of this ore tested gave 2 per cent manganese, and another showed 3 per cent manganese. The ore occurred in veins 3 to 10 feet wide and was worked in open cuts. Three pits were opened at a distance of one-half mile from the station.

"On the Cooper place, one-half mile from Marble, N. C., Betts & Company operated an iron mine producing ore 48 per cent to 49 per cent iron. At first the cost was $2.20 per ton, but this was reduced to $1.18 by expert management. About 3,000 tons of ore have been shipped from here and the company have obtained the mineral rights on 150 acres.

"On the Whittier property, 3 miles south of Andrews, is the Cover and Porter's iron mine. They own mineral rights on 201 acres, and began mining May 1, 1917. After shipping 1,000 tons to LaFollette, Tennessee, they installed 1 mile of 4-inch iron pipe and began hydraulic iron mining with the level of the pit but a few feet above the bottom of the valley of the branch of the Tatham Creek, near which the mine is located. The first opening was made several hundred yards from the present pit and higher on the hill. The ore has been proved through a distance of half a mile along the lower slope of the hill and the present pit is about one-third of the distance from the south end of the ore. Ten men are employed in the pit at $1.75 to $2.00 per day and 8 teams haul the ore a half mile to a siding on the Nantahala (Lumber) Railroad. They are loading 2 cars daily at a cost of 70c to 80c per ton, including the expense of mining. The ore is sold to the Virginia Iron, Coal and Coke Company of Middlesboro, Kentucky. This ore sometimes runs 55 per cent or 56 per cent, but averages about 51 per cent to 52 per cent. At first the ore was hauled 3 miles to Andrews and loaded on cars at a total cost of $1.25 per ton. The water piped has a head of 130 feet, which gives it great force in the pit. The nozzle is arranged on a swivel so that the stream can be played upon the ore in a complete circle if necessary."

THE TITANIFEROUS IRON ORES*

"Titaniferous magnetites occur at a number of localities in the Piedmont and Appalachian regions of North Carolina, but no deposits of great promise are known. The rocks of this western half of the State consist principally of a complex of gneisses, ranging from acidic or granitic gneisses to very basic rocks, as hornblende gneisses, granites, and other igneous rocks. The most recent and complete account of the titaniferous magnetites occurring in this region is contained in the bulletin on the iron ores of the State by Nitze.[1] This report includes all information in previous reports of the State survey, and, except for data relative to the localities visited by the author of this report, it forms the basis of the following account.

"As most of the localities cited in the North Carolina reports show no evidence of the existence of deposits of any importance, it was considered useless to attempt to visit all, and at the suggestion of Dr. J. H. Pratt, State Geologist of North Carolina, the author visited what were

*Taken from Bulletin 64 of the Publications of the Bureau of Mines on "The Titaniferous Iron Ores in the United States—Their Composition and Economic Value," by Joseph T. Singewald, Jr., pages 80-93, inclusive. Published in 1913.

[1]Nitze, H. B. C., A preliminary report on the iron ores of North Carolina: North Carolina Geol. Survey Bulletin 1, 1893.

considered the two most promising areas, the belt extending across Rockingham, Guilford, and Davidson counties, just west of Greensboro, and the area to the north of Lenoir, in Caldwell County.

"The general distribution and character of the ores is very briefly indicated; a more detailed description is given only of the two areas visited by the writer.

Distribution and Character of the Ores

"References to the character of the immediate country rock of the ores are very meager and of a most general nature. All that can be gotten from the literature is that it is in most cases a schistose femic rock. No information as to what the original rock might have been is given. Little can be said, therefore, in regard to the geology of the ores.

"Our knowledge of the character and extent of the ores is more complete, as a large number of analyses have been made, and some data are given indicating the size of the ore bodies. The table following gives the available analyses, arranged alphabetically by counties. It is the same as that given by Nitze,[2] with five analyses added in Guilford County taken from Lesley.[3]

[2]Op. cit., pp. 229-231.
[3]Lesley, J. P., Notes on the titaniferous iron belt near Greensboro, N. C., Proc. Am. Phil. Soc., Vol. 12, 1871, pp. 154-156.

RESULTS OF ANALYSES OF NORTH CAROLINA ORES.

Source of Ore	SiO_2	Fe	Mn	S	P	TiO_2	Cr_2O_3	Al_2O_3	$CaCO_3$	MgCO	CaO	MgO
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
ALLEGHANY COUNTY—												
1. Fielden Carrico, Old Forge workings	6.20	54.72		0.038	0.047	4.86						
ASHE COUNTY—												
2. Cicero Pennington, Wallens Creek	4.75	52.23		.112	.021	8.91	1.19					
3. Cicero Pennington, Wallens Creek	4.72	52.44		.077	.004	5.38						
4. Cicero Pennington, Wallens Creek	5.07	52.45			.022	9.11						
5. Baugues opening, near Little Helton Creek	6.35	57.66		.061	.008	4.69	.505					
6. Baugues opening, near Little Helton Creek	7.91	53.35		.078	.022	4.92						
7. G. C. McCarter, Little Helton Creek	9.90	46.81		.137	.025	6.03	.63					
8. G. C. McCarter, Little Helton Creek	10.92	40.71		.065	.012	5.54						
9. G. C. McCarter, Shipps Branch opening	5.37	51.75			.018	9.17						
10. William Young, Little Helton Creek	5.12	50.77		.04	.005	4.95						
11. William Young, Little Helton Creek	4.35	52.85			.013	8.80						
CALDWELL COUNTY—												
12. J. K. Farthing, Warrior Creek	6.50	31.92	0.39	.058	.025	2.40			7.48	15.64		
13. Joshua Curtis, Yadkin River (average)	6.63	36.00	1.09	.021	.060	14.90			7.37	16.08		
14. Joshua Curtis, Yadkin River (selected)	7.55	28.24		.013	.140	41.21						
15. Joshua Curtis, Yadkin River		37.10			Trace	36.40						
16. Joshua Curtis, Yadkin River		25.76			.076	38.81						
CATAWBA COUNTY—												
17. Forney ore bank, near Maiden Station	1.41	67.92		.07	.025	1.60						
DAVIDSON COUNTY—												
18. K. R. Swain, Massive ore	.76	57.68				13.52	.46	1.68				
19. K. R. Swain, Micaceous ore	5.68	52.68				11.67	.48	5.08				
DAVIE COUNTY—												
20. Kelley-Lefler place, 5 miles south of Mocksville	.778	60.00		.033	.008	10.32						
21. Allen place, 7 miles northeast of Mocksville	5.50	52.80		.11	.02	8.00						
GUILFORD COUNTY—												
22. Elisha Charles	.40	59.03				11.95	1.07	1.06				
23. Widow Cook	1.84	56.21				13.28	.65	2.30				
24. John Clark	1.30	56.41				12.35	1.10	2.54				
25. Sargeant Shaft	1.31	55.06				13.60	.72	4.26				
26. Sargeant Shaft		53.20			.005	Present						
27. Sargeant Shaft	12.86	53.27				13.58						
28. Mrs. McCuiston, soft Micaceous		43.47				16.06						
29. Mrs. McCuiston, soft micaceous	12.75	41.95				15.35	1.25	5.17				
30. Mrs. McCuiston, Magnetic part of above	1.30	67.60				1.27	1.43	.55				

RESULTS OF ANALYSES OF NORTH CAROLINA ORES—Continued.

Source of Ore	SiO_2	Fe	Mn	S	P	TiO_2	Cr_2O_3	Al_2O_3	$CaCO_3$	$MgCO_3$	CaO	MgO
GUILFORD COUNTY—*Continued.*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
31. Mrs. McCuiston, Nonmagnetic part of above	26.80	21.63				16.20	.43	8.87				
32. Mrs. McCuiston, massive ore		33.97				2.63						
33. W. A. Lewis	.50	57.32				12.27	.57	3.62				
34. Belt, west of Greensboro (*a*)	.75	57.77	.22			12.08	.32	4.62			0.13	2.04
35. Belt, west of Greensboro	1.89	59.95	.32			8.72	.40	3.93			.17	1.36
36. Belt, west of Greensboro	1.04	58.52	Trace	Trace	.00	12.32	Trace	3.87			.64	.49
37. Belt, west of Greensboro	1.50	60.41	.08	.00	Trace	8.65	.83	2.90			.75	2.02
38. Belt, west of Greensboro	.52	57.30	.48	.00	.00	13.74	Trace	4.50			.72	.54
LINCOLN COUNTY—												
39. Lawson Bess, Indian Creek	11.37	56.95		.045	.029	2.40						
MACON COUNTY—												
40. Felix Kilpatrick, 5 miles east of Franklin	.77	54.24		.04	.013	17.60						
41. Alex. Waldrop, 6 Wiles west of Franklin	11.91	20.64	.69	.089	.016	3.20			3.31	14.69		
MADISON COUNTY—												
42. Road, midway between Asheville and Burnsville	.83	36.26	.63	.09	Trace	37.88		9.51				
43. John Brigman, Paint Fork	*											
44. Swan Woody, Spring Creek	2.37	62.16		.026	.014	7.44						
MITCHELL COUNTY—												
45. Avery land, Roaring Creek Yellow Mountain	1.46	65.32		.025	.009	4.80						
46. Avery land, Roaring Creek, Yellow Mountain	.54	66.95		None	.015	6.80						
47. Parker place, 2 miles west of Burnsville	1.22	57.98		.015	.041	4.56						
48. Joel Gouge, mouth of Little Rock Creek	1.13	64.56		.027	.078	4.48						
49. Above Jenkins mine, Greasy Creek	6.58	54.48		.023	.033	4.96						
ROCKINGHAM COUNTY—												
50. Levi Shaw	1.80	54.17	.96			14.46	.97	2.66				
51. P. Hopkins	.74	55.61	.82			13.92	1.07	3.82				
52 Granular reddish ore	1.39	30.97	.63			.78	.30	52.24				
53. Granular grayish ore	.98	33.52	.80			2.42	Trace	44.86				
54. Dannemora mine	4.71	48.41		.089	.023	13.74	.34	8.68				
55. Dannemora mine, fine ore		49.41	Trace		.001	Present						
YANCEY COUNTY—												
56. Mine Fork, 6 miles north of Burnsville	9.25	39.42		.12	.011	11.90						
57. Jerry Ferguson, 9 miles west of Burnsville	23.38	39.00				2.56						

*a*Ore represented by this analysis had a trace of V_2O_5. *Titanic acid present in large quanity.

"These analyses show a considerable range in TiO_2 content; whereas a number carry only a small percentage of TiO_2, others have such a high percentage that the ore must consist almost entirely of ilmenite. The phosphorus ratio in nearly all of the ores is below the Bessemer limit, and sulphur is low. The percentage of iron is also high in most of the analyses. Except for their titanium content, most of the ores would be classed as medium to high grade.

Alleghany County

"A zone of hornblende schists, in many places altered to steatite or soapstone, and carrying crystalline grains of magnetite, usually titaniferous, extends across Alleghany County parallel to the Little River and usually on the south side of it. Locally the magnetite becomes more abundant in the schists and may be sufficiently concentrated to form small lenses of ore. On the farm of Fielden Carrico, near the State line, several such ore bodies were opened up about 30 years ago to supply a near-by forge in Virginia (see analysis 1). These openings have long since been abandoned and caved in.

Ashe County

"A belt of titaniferous magnetite extends in a northeasterly direction from Helton Creek, near Sturgill, to Little Helton Creek, a distance of 2½ miles. The analyses of the ores in this belt (analyses 2 to 10) show a moderate titanium content.

"At the northeast end of the belt is a series of outcrops, one of which shows an ore bed at least 25 feet wide. It is a coarse granular magnetite practically free from gangue. The country rock is in part a prophyllite schist and in part a hornblende rock altering to asbestos. South of these outcrops is another showing 5 feet of ore with a gangue of epidote, feldspar, and quartz. At the southwest end of the belt are several more outcrops, in which the width of the ore ranges from 8 to 15 feet. The ore is a fine-grained magnetite with a gangue of hornblende and epidote.

Caldwell County

"Two localities in this county were visited by the writer, but neither showed either large or promising deposits.

Richlands Cove Deposit

"Sixteen miles north of Lenoir in what is known as the Richlands Cove is a body of titaniferous iron ore on the east bank of the Yadkin River. A small opening has been made adjacent to the river bank

exposing a face about 20 feet high and 40 feet wide. This titaniferous mass occurs within a country rock consisting of sericitic schist. It consists of small particles of ore in a matrix chiefly made up of fibrous and scaly aggregates of chlorite, serpentine, and talc. The individual ore particles average less than one-half mm. in diameter, and rarely exceed 1 mm. They are very slightly magnetic to nonmagnetic. Two polished sections of the ore etched with hydrochloric acid retained their luster and showed no evidence of the intergrowths of ilmenite and magnetite. These facts, together with the high titanium content shown in the analyses in the tables (analyses 13 to 16), indicate that the ore particles consist chiefly of ilmenite. This is further borne out by the fact that the sands along the river close to the deposits contain only nonmagnetic ore particles.

"Just north of the opening on the river bank is a small side valley in which a rock of identical character outcrops. This outcrop is about 300 feet from the river on the north side of the valley.

"Neither of these deposits shows extensive outcrops, and they seem to be only small intercalations in the more acidic country rock. They undoubtedly represent small basic intrusions that have undergone metamorphism with the rest of the region.

"The titanium content is so high that the deposits cannot be regarded as iron ores. As sources of titanium, their inaccessible location and seeming small size are great drawbacks. At present they possess no economic value.

Farthing Deposit

"On the north side of Warrior Creek, 5½ miles north of Lenoir, there are outcrops of an ore bearing rock. The rock consists principally of a green hornblende schist carrying considerable ore disseminated in minute grains and in stringers of nearly pure ore. It occurs as an intercalation in more acidic schistose rocks. Similar rock can be traced for some distance to the southwest by means of surface fragments, but no openings have been made on this occurrence.

"Locally this hornblende rock contains richer portions of fine-grained ore. A thin section of such a piece consisted principally of the ore minerals and spinel. Less abundant were augite and hornblende. The ore grains are less than 0.5 mm. in diameter, and do not constitute more than one-third of the mass. On etching polished surfaces of these ores the small magnetite grains are dissolved out without showing any ilmenite intergrowths, and the polished surfaces of the ilmenite remain unattached. Further evidence that the small pits on the polished surface were occupied by magnetite is the fact that a considerable part of the powdered ore is magnetite. Analysis 12 shows the composition of the ore.

"Adequate exposures to enable one to judge accurately the extent of the occurrence are lacking. The richer parts of the rock are so lean, however, as to preclude any possibility of working the deposit.

Catawba County

"A belt of titaniferous ore extends across parts of Catawba and Lincoln counties, from a point southwest of Newton to about 9 miles west of Lincolnton. At the northeast end is the Forney mine, which formerly supplied several forges in the neighborhood. The ore is a coarse granular magnetite, usually free from gangue, and occurs in irregular pockets a few inches to 3 or 4 feet in thickness. The country rock is called syenite in the North Carolina report. An analysis of the ore (analysis 17) shows a low titanium content. Float ore found in this belt at the southwest end also shows (analysis 39) only a small percentage of titanium.

Davidson County

"See Guilford County.

Davie County

"Titaniferous ores are described at two points in Davie County near Mocksville.

"About five miles south of Mocksville, near the mouth of Bear Creek, is a fair showing of float ore for a distance of 600 feet on the old Maxwell place. Float ore can be traced at intervals for $1\frac{1}{2}$ miles to the southwest to the South Yadkin River. The country rock is described as "hornblende and syenite, with occasional dissemination of magnetite granules." The ore is a medium grain magnetite with little gangue (analysis 20).

"Similar ore occurs 7 miles northeast of Mocksville and one mile east of Kernatzer station. Several pits and a shaft were put down here during the Civil War. The ore was worked in a forge four miles distant on Dutchmen's Creek. Float ore can be traced faintly 200 to 300 yards northeast and southwest of the old shaft (analysis 21).

Guilford County

"A belt or titaniferous magnetite extends across Guilford County in a northeasterly direction, and passes beyond the boundaries of Guilford County into Rockingham County on the northeast and into Davidson County on the southwest. It lies to the north and west of Greensboro. It consists of two parallel subordinate belts known, respectively, as the Tuscarora belt and the Shaw belt, the total length of which is 30 miles.

The longer and more persistent is the Tuscarora belt. The Shaw belt lies several miles northwest of it.

"The area is one of prevailing granites and gneisses within which are smaller bodies of gabbro. Though evidence of the presence of the gabbro is obtained repeatedly along the belt by outcrops and surface fragments, it seems that the belt is not one elongated mass of gabbro, but consists of a number of smaller masses having a linear distribution along the belt. The ore bodies are segregations within these small gabbro masses and do not constitute a continuous body extending the entire length of the belt.

"Surface outcrops of the ore bodies are lacking, and as the old workings have all caved in the character of the ore can be judged only from the surface fragments. A detailed examination of the belt was made by Lesley[1] for a Philadelphia mining company, and trenching was done at a number of points to expose the ore. Dr. Lesley consequently had unusual opportunities for observing the ore bodies, and his account of them is the most valuable we have. Shortly after this the belt was visited by Prof. W. C. Kerr and Dr. F. A. Genth, and described in a report of the North Carolina Geological Survey.[2] The descriptive part is taken mainly from Lesley's report, but 16 additional analyses made by Genth are given. This same report was reprinted with slight alterations in 1883[3] and again in 1893.[4] A brief sketch is also given in the Tenth Census reports.[5]

"It is not surprising that Dr. Lesley at that early date misinterpreted the genesis of the ores. He regarded them as bedded deposits of sedimentary origin, and consequently the conclusions he drew as to the geology and structure of the deposits are erroneous. These are of historical interest only and will not be repeated here. The records of his observations, however, supply facts no longer accessible on account of the filling of the old workings and trenches. The ore bodies consist of strings of lens-shaped masses, continually enlarging and contracting in thickness from a few inches to 6 and 8 feet. 'The principal beds may be safely estimated at an average of 4 feet, and in the best mining localities the average yield of a long gangway may reach 5 feet.' The occurrence of the ore body in a series of disconnected lenses is consequently verified by the observations of Prof. Lesley.

[1]Lesley, J. P., Note on the titaniferous iron ore belt near Greensboro, N. C., Proc. Am. Phil. Soc., vol. 12, 1871, pp. 139-156.
[2]Report of the Geological Survey of North Carolina, vol. I, 1875, pp. 236-250.
[3]Kerr, W. C., and Hanna, G. B., Ores of North Carolina: Geol. Survey of North Carolina, 1888, pp. 143-154.
[4]Nitze, H. B. C., A preliminary report on the iron ores of North Carolina: North Carolina Geol. Survey Bull. 1, 1893, pp. 60-68.
[5]Tenth Census, vol. 15, 1886, pp. 308-311.

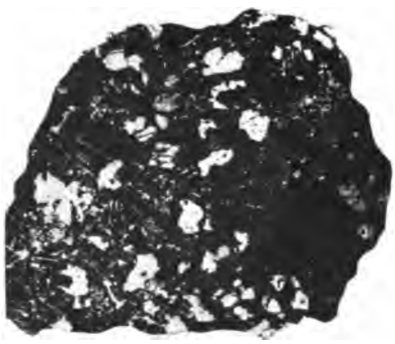


Fig. 1. Tuscarora Mine, N. C., Ore. (X 2.)

Tuscarora Mine

"This mine was worked in the seventies by a Philadelphia mining company. Forges were erected on a small stream a half mile northeast of the principal shaft, and considerable iron is said to have been made. It seems that the titaniferous ores could readily be smelted in the old Catalan forges and yielded a superior grade of iron. The Tuscarora mine consisted of several shafts extending about a mile along the ore belt. The principal shaft, the Sargeant, was situated a mile and a half north of Friendship. It reached a depth of 109 feet and a tunnel run in from this depth is said to have cut a bed 12 feet wide.

"Outcrops of granitic gneisses occur in the vicinity of the mine, but the immediate country rock is a gabbro. It is an olivine gabbro with diabasic texture, in which the feldspar laths reach a length of 2½ mm., and the pyroxene and olivine grains have a diameter of 1 to 1½ mm.

"No ore in place is now exposed, but judging from the fragments lying about on the surface it is a medium to coarse grained ore of good grade, in which the principal gangue consists of tufts and seams of chlorite and small quantities of material so decomposed as to make it undeterminable. Analyses 25 to 27 give the composition of the ore.

Metallographic Description of Ore

"Polished sections of this ore show very striking features. Gangue minerals constitute only a small part of the surface. Ilmenite grains make up one-fifth to two-fifths of the surface; and they range in size from 2 mm. to 0.2 mm., though very few fall below 0.5 mm. in diameter. The most striking feature of the ore is the ilmenite intergrowths in the magnetite, which attain a coarseness not approached in any of the other ores that have been studied. Indeed, so coarse are they as to be easily discernible with the naked eye. An etched specimen of the ore is shown in Fig. 1, in which the relations of the ilmenite and the magnetite grains and the heavy ilmenite laths in the magnetite are apparent. The individual ilmenite plates have an average length of 2 mm., but some attain a length of as much as 4 mm. The space between the parallel plates varies from 0.2 to 0.5 mm., and the plates themselves may be as thick as 0.1 mm. Another characteristic feature is protuberances or local thickenings of the plates. This most frequently takes place at one end, the other end thinning out, giving an elongated, wedge shaped appearance. These plates are plainly visible on cleavage faces of the magnetites on the unpolished surfaces of pieces that have been etched, and are frequently coarse enough to peel off with the edge of a knife blade.

Possibilities of Utilizing Ore

"The most satisfactory results of magnetic separation were obtained from this ore, as shown below:

Results of Magnetic Separation of Tuscarora Ore.

	Unscreened Ore, Per Cent	Ore Through 50-mesh, Over 100-mesh (a)		Ore Through Screen Finer Than 100-mesh (b)
		Magnetic, Per Cent	Nonmagnetic, Per Cent	Magnetic, Per Cent
Quanity		71.5	28.5	70.1
Fe	58.07	67.76	33.76	68.41
TiO_2	12.82	4.25	34.32	3.64

a44.6 per cent. b55.4 per cent.

"These results show that little is to be gained by grinding finer than 50-mesh; that is, notwithstanding the coarseness of the ilmenite intergrowths they are still too fine to be separated by grinding to 100-mesh. This, of course, is obvious from a comparison of the dimensions of the intergrowths given above and the size of the openings of the 100-mesh screen. If all the TiO_2 in the tailings is assigned to the ilmenite, they contain about 75 per cent ilmenite, with a residue of 6.38 per cent Fe. Some of this iron occurs in the gangue minerals present, so that very little magnetite is lost by adhering to the ilmenite or gangue. Although the titanium content of the concentrate is still higher than is acceptable in present blast-furnace practice, the concentrate is so high grade that it would make an acceptable ore to mix with titanium-free ore.

"Kerr[1] gives the results of a magnetic-separation test made with a common magnet on ore obtained from this same belt several miles northeast of the Tuscarora mine. They are even more favorable than those presented above.

Results of Magnetic Separation Test of Tuscarora Ore.

Constituent	Natural Ore, Per Cent	Magnetic, Per Cent	Nonmagnetic, Per Cent
Fe	41.95	67.60	21.63
TiO_2	15.35	1.27	16.20
SiO_2	12.75	1.30	26.80

[1]Report of the Geological Survey of North Carolina, vol. 1, 1875, p. 245.

Trueblood Plantation Ore

"About 2 miles northeast of the Tuscarora mine, on the south side of Brushy Creek, a little work has been done. The ore here also occurs in association with a gabbro. The gabbro is strongly uralitized and the feldspar sufficiently altered to make the twinning obscure in places. Diabasic texture is far less prominent than in the rock of the Tuscarora mine, and often lacking entirely. The average size of the grains is about 2 mm.

"The ore is not quite as coarse as the Tuscarora mine ore, and etched sections do not show the intergrowths as abundantly. Otherwise the ore at the two localities is very similar in appearance.

Apple Plantation Ore

"Some pits were put down on the Apple plantation just over the line in Rockingham County, southeast of the Haw River, but they are all filled now. Fragments of ore found on the surface are similar to the ore found on the Trueblood plantation. Of special interest to this locality are fragments of pink and gray emery. The occurrence of emery in this belt is first mentioned in Kerr's report,[1] in which he gives two analyses made by Genth. One analysis is of a reddish granular ore (analysis 52), which he describes as follows: "It has much the appearance of a granular reddish-brown garnet, for which it has been mistaken, until the analysis proved it to be not a silicate mixed with granular magnetite, but corundum." The other is of a granular grayish ore (analysis 53) described as follows: 'This is of a similar quality and is found at the same locality; the minute grains of corundum have a yellowish or brownish-white color, and show in many places cleavage fractures, which give it the appearance of a feldspathic mineral.' No mention is made of the locality where these specimens were found. Pratt and Lewis[2] state that the exact location is not now known, and give the McCarviston or McCuiston place, 7 miles northeast of Friendship, in Guilford County, as the probable location. The specimens found on the old Apple plantation fit the description given by Kerr exactly, and as no such material was found anywhere else in the belt, it seems probable that this is the locality from which Kerr's specimens were obtained. The rock was not found in place and no conclusions could be drawn as to the occurrence and size of the deposit.

[1]Report of the Geological Survey of North Carolina, vol. 1, 1875, p. 246.
[2]Pratt, J. H., and Lewis, J. V., Corundum and the peridotites of western North Carolina: North Carolina Geol. Survey, vol. 1, 1905, pp. 263-264.

Dannemora Mine

"Some work was done on the Shaw belt, 3 miles west of Summerfield, but the only extensive workings were those on the north side of the Haw River, close to the line between Guilford and Rockingham counties. Ore was worked from pits in Revolutionary times, and hauled to Troublesome Forge, 5 miles to the north. Subsequently a Philadelphia mining company worked the Dannemora mine on this property. The following description of the mine, given by Bailey Willis in the Tenth Census report,[3] is quoted because it gives the size of one of the ore lenses:

'The first work was done in incline No. 1. According to the statement of the superintendent, the ore gave out 10 feet from the surface but was found again 20 feet farther down; it widened to 12 feet, which is the thickness 90 feet from the surface in the incline, 70 feet vertically. At this depth a drift has been driven along the vein and stoping has been begun. A small winze has been sunk 20 feet farther on the incline, and the ore is said to narrow to 1 foot in thickness. Before the horizontal drift reached the second incline the ore was pinched out by the granite walls.

'As the ore body thus opened gives out just beyond incline No. 1, its dimensions are pretty well ascertained. It is approximately 125 feet long, 80 feet in incline width, and 12 feet thick. The drift has been extended to another lens of the same thickness, northeast of it, and the surface outcrops and trenches indicate the existence of others to the southwest. The ore is accompanied by chlorite and mica, which are sufficiently decomposed, even at the depth of the tunnel, to be readily dug with a pick. The ore is separated on the surface, by screening, into lump and fine ore, the former being shipped for fettling, the latter for blast-furnace use.'

"The ore lying about the old workings is somewhat leaner than the Tuscarora mine ore. It consists of a similar granular aggregate of ilmenite and magnetite with the gangue minerals, but the individual grains seldom exceed 1 mm. in diameter, and most of them are about 0.5 mm. Intergrowths of ilmenite in the magnetite grains are almost lacking.

Summary

"The titanium content of these ores is about the normal one for titaniferous magnetites. Of the large number of available analyses the average TiO_2 content is about 13 per cent. The ilmenite and the magnetite occur as granular aggregates in the ores in such a manner that most of the titanium can be eliminated with little loss of magnetite. The resulting concentrate runs high in iron and is low enough in titanium to make possible the utilization of these ores in normal blast furnace practice by mixing them with titanium free ores. On the other hand, little is

[3]Tenth Census, vol. 15. 1886, p. 308.

known in regard to their geologic occurrence and size on account of lack of exposures. Such conclusions as can be drawn from old data and the nature of the deposits are not very favorable to them. The ore bodies seem to be rather small and irregular in distribution, so that mining operations would be attended by considerable uncertainty. On the whole, therefore, the belt is not very promising as a source of iron ore.

Lincoln County

"See Catawba County.

Macon County

"There are a number of occurrences of titaniferous magnetite in Macon County east and south of Franklin, but none has been explored more than superficially.

"Five miles east of Franklin and one-eighth of a mile north of Cullasagee Creek there is a heavy surface float of massive lustrous magnetite high in titanium (analysis 40). The gangue is quartz and chlorite; the ore is traceable for several hundred yards along the summit of a hill in a northeasterly direction parallel to the strike of the decomposed mica schists near the foot of the hill.

"An analysis has also been made of the ore on land 4 miles southwest of Franklin and 2 miles above the mouth of Cartoogajay Creek (analysis 41). The ore is very fine grained, in a chloritic gangue, and in places slightly garnetiferous. The extent of the ore body is not apparent.

Madison County

"No important bodies of titaniferous ore are known in Madison County, though there are several occurrences of the ore.

"In the eastern part of the county, a half mile above the mouth of Paint Fork, small pieces of float ore high in titanium are found (analysis 43). The occurrence of a highly titaniferous ore is also noted near the road midway between Asheville and Burnsville (analysis 42).

"An occurrence showing only a moderate amount of titanium is that a half mile east of the Haywood County line near the headwaters of Spring Creek (analysis 44). It has a thickness of 5 to 6 feet near the surface and appears to widen in depth.

Mitchell County

"Titaniferous ores occur in Mitchell County in the Roan Mountain belt, the Pumpkin Patch Mountain belt, and on Iron Mountain.

"Titaniferous ores occur on one of the spurs of Iron Mountain 2½ miles above the mouth of Greasy Creek, near the Jenkins ore bank

(analysis 49). The ore body consists of a compact lustrous ore free from gangue, and attains a width of 5½ feet. The wall rock is hornblende gneiss and pegmatite.

"The Roan Mountain titaniferous belt lies several miles south of the Cranberry belt, to which it is parallel. Its eastern extremity is near the mouth of Roaring Creek on one of the southern spurs of Big Yellow Mountain. It crosses the State line on the summit of Grassy Bald Ridge, then, after traversing the eastern edge of Tennessee for about 4 miles, bends around to the southwest and reenters North Carolina near the headwaters of Big Rock Creek; thence it continues to the mouth of Big Rock Creek to the Yancey County line at Toe River. No ore bodies of any size have been found along this belt. At the eastern end some prospecting has been done, including the drilling of three diamond-drill holes. The results were discouraging, as the ores occur in lenses of 2 inches to 2 feet in width. The titanium content is only moderate in amount (analyses 45 and 46). The ore is compact, lustrous, and free from gangue, and occurs in a country rock of very coarse grained pegmatite, hornblende schist, epidote, and garnet rock.

"At the southwest end of the belt on the north side of Little Rock Creek a small pit exposes a bed 3 feet wide, which at a depth of 4 feet is cut out by a diabase dike (analysis 48).

"The Pumpkin Patch Mountain titaniferous magnetite belt lies to the northwest of Bakersville and has an extent of 5 to 6 miles. Some pits have been put down on the Parker place near the head of Wadkins Branch, 5 miles northwest of Bakersville, and loose blocks of ore encountered (analysis 47); the pits did not go deep enough to get the ore in place.

"All of these Mitchell County ores show approximately the same titanium content.

Rockingham County

"See Guilford County.

Yancey County

"The occurrences of iron ore in Yancey County are isolated and sporadic, and no notable occurrences of titaniferous ore have been disclosed.

"In the extreme western part of the county near the head of Possum Trot Creek, 9 miles west of Burnsville, is found float ore that shows a small amount of titanium (analysis 57). It is possible that this occurrence belongs to the Roan Mountain titaniferous belt of Mitchell County.

"Another deposit occurs 6 miles north of Burnsville, on the south side of Mine Fork, a half mile above its mouth (see analysis 56). Two small openings were made 75 feet apart on the strike of the ore (N. 25°

E.) and show a vertical bed of ore 6 to 10 feet across. The ore is in a gangue of chlorite, small particles of quartz and feldspar, and a peculiar brown mineral of high luster which may be rutile or brookite. A quarter mile southwest of these openings is much surface float of this heavy brown mineral nearly free from magnetite. If this mineral is really rutile or brookite, considerable titanium could easily be eliminated by magnetic concentration."

Production

There is given in the table below the production and value of iron ores for North Carolina from 1900 to 1917, inclusive:

PRODUCTION OF IRON ORES IN NORTH CAROLINA, 1900—1917, INCLUSIVE.

Year	Amount, Long Tons	Value
1900	21,000	$ 42,000
1901	2,578	4,997
1902	34,336	52,771
1903	82,851	78,540
1904	64,347	79,846
1905	56,282	70,352
1906	56,057	75,638
1907	75,638	113,488
1908	48,522	76,877
1909	61,150	107,013
1910	65,278	114,237
1911	84,782	148,369
1912	68,322	186,264
1913	69,235	211,791
1914	57,667	100,917
1915	66,453	116,472
1916	64,306	249,948
1917	90,957	445,898

Owners and Producers of Iron Ore in North Carolina During 1917

Cover and Porter, Andrews, Cherokee County, N. C.....Cover Mine
Ferebee & Young Co., Andrews, Cherokee County, N. C..Faco, Nos, 1, 2 and 3
Coe & Holland Co., Andrews, Cherokee County, N. C....Coe-Holland Mine
J. W. Porter, Andrews, Cherokee County, N. C.........Adams Mine
Latham & Swan, Andrews, Cherokee County, N. C.....Latham & Swan Mine
John J. George, Cherryville, Gaston County, N. C.......Ellison Ore Bank
Cranberry Furnace Co., Johnson City, Tenn...........Cranberry Mine, Avery County
J. W. Welch, Marble, Cherokee County, N. C...........Welch Mine
Marble Iron Mining Co., care Anson G. Betts & Co., Asheville, N. C.....................................Marble Mines Cherokee County

Shut-In Iron Mines, Inc., care Anson G. Betts & Co.,
Asheville, N. C. .... Shut-In Mines, Madison County
J. S. Stanbury, Marble, Cherokee County, N. C.
N. C. Bessemer Co., Thos. M. Gorman, Sec'y, Durham,
N. C. .... Mines, McDowell County
Charlton B. Rogers, 154 4th Ave., Nashville, Tenn...... Mines, Cherokee County
J. T. Hayes, Tomotla, Cherokee County, N. C.
A. K. Knickerbocker, Hot Springs, Madison County, N. C.
W. R. Lunsford, Marble, Cherokee County, N. C....... Marble Mine
Rolin Dockery, Marble, Cherokee County, N. C......... No. 6 Mine
F. R. Seeley, Murphy, Cherokee County, N. C.

TIN

A report has recently been published by the United States Geological Survey on "The Tin Resources of the Kings Mountain District of North Carolina and South Carolina." Because of the value of this report to those interested in the North Carolina tin deposits, it is incorporated with this report.

Tin Resources of the Kings Mountain District, North Carolina and South Carolina*

BY ARTHUR KEITH AND DOUGLAS B. STERRETT

INTRODUCTION

The Kings Mountain district, in which the tin ores here described are found, is included in the Gaffney, Kings Mountain, Lincolnton, and Gastonia quadrangles mapped by the United States Geological Survey. The district is almost equally divided between North Carolina and South Carolina, the part in North Carolina being a little larger.

The examinations on which this report is based were made by the authors in preparing the Gaffney-Kings Mountain and Lincolnton-Gastonia folios of the Geologic Atlas of the United States. A previous and less detailed examination was made by L. C. Graton.[1] Mr. Sterrett carried on his work in 1908 and in subsequent years up to 1914. The district has also been examined in detail by Mr. Keith, in company with Mr. Sterrett, with special reference to the general geology and the formations and structures of the region.

*Bull. 660-D of the U. S. Geol. Survey.
[1]Graton, L. C., Reconnaissance of some gold and tin deposits of the southern Appalachians: U. S. Geol. Survey Bull. 293, 1906.

GEOGRAPHY

The Kings Mountain district is in the central part of the Piedmont Plateau, of which it may be considered a typical area. The country is one of broad, flat or gently rolling ridges that become more broken near the larger streams, where deep valleys have been cut. The sky line as viewed from the higher ridges is that of a nearly level plain, above which stand a few elongated hills and mountains, called monadnocks. Most of these hills are in a narrow, central, northeastward trending belt.

A few low ridges rise above the plateau surface in the southeastern part of the Lincolnton quadrangle, but these do not compare in height and roughness with the more prominent peaks in the Kings Mountain quadrangle, to the south. The smooth, broad ridges pass rather sharply into steeper slopes at the foot of the monadnocks and near stream valleys. Many of the valleys in these quadrangles are rather broad and have nearly flat bottoms, but some are V-shaped, with steep walls. The relief where the rivers and larger streams are cutting through hard rocks is considerable, and the hillsides are steep and rocky.

Characteristic developments of the rolling upland country may be seen between Kings Mountain and Cherryville and on to the northwest beyond Flay. The relief for considerable distances along the ridges in these areas is low, and the side valleys are shallow. The cultivated lands are smooth fields with deep residual soil and only scattered outcrops of rock.

The plateau ranges in elevation from 750 to 1,050 feet above sea level, but most of it is between 850 and 1,000 feet. The highest parts are in general on the northwest, and there is a decided general slope to the southeast. The stream valleys are cut 50 to 200 feet below the general plateau surface, and the residual hills, or monadnocks, stand from 100 to 700 feet above it. The highest points are Kings Mountain Pinnacle, 1,705 feet, and Crowders Mountain, 1,624 feet above the sea.

The town of Kings Mountain is situated at an elevation of 1,000 feet on the principal divide, which has a general northwest course between the drainage basins of Catawba and Broad rivers and separates the district into nearly equal parts. Broad River takes a southeasterly course through the Gaffney quadrangle and across a corner of the Kings Mountain quadrangle. Its principal tributaries are Kings, Bullocks, Buffalo, Cherokee, and Thicketty creeks and First Broad River. The chief tributaries of Catawba River are Indian, Crowders, Allisons, Clark, and Beaverdam creeks and the South Fork of Catawba River.

The Southern Railway runs from southwest to northeast through the middle of the district and connects most of the principal towns, including

Gaffney, Blacksburg, Kings Mountain, Bessemer City and Gastonia. The Kingville and Marion branch of the Southern Railway runs from southeast to northwest and crosses the main line at Blacksburg. A branch of the Seaboard Air Line Railway runs southwestward through Lincolnton and Cherryville. Between Bessemer City and Gaffney the Southern Railway passes within a mile or two of the tin belt, and no known deposit of tin ore in this belt is more than 3 miles from a railroad.

Descriptive Geology

Piedmont Plateau

The rocks of the Piedmont Plateau are of both igneous and sedimentary origin. Both kinds of rock have been metamorphosed in many places. In some localities the metamorphic igneous and sedimentary rocks are not sharply distinct, for the metamorphism has been so extreme that nearly all traces of original sedimentary or igneous nature have been obliterated. In many places also the metamorphic igneous rocks are not sharply separable from the ordinary igneous rocks, for a single intrusive mass may have become metamorphosed in some parts, especially near its borders, during processes of mountain building and may show little or no evidence of change in other parts, particularly in the interior.

The metamorphic rocks of sedimentary origin in the Piedmont Plateau consist of gneisses and schists, the principal varieties of which are those characterized by muscovite, or biotite, garnet, kyanite, staurolite, chlorite, sericite, ottrelite, and, in some rocks, quartz and calcite. All these varieties have resulted from the metamorphism of ancient sedimentary rocks such as conglomerates, sandstones, shales, limestones, and numerous intermediate kinds. By metamorphism sandstone became quartzite, impure or shaly sandstone became graywacke and gneiss, shale became schist, and limestone became marble. Variations in composition of the original sediments are represented by variations in the metamorphic rocks. Some of the sediments were in part of volcanic origin, such as volcanic ash or tuff laid down in water with varying amounts of detrital material derived from ordinary land waste. The metamorphism of these rocks has produced varieties of crystalline rocks transitional between those of purely sedimentary origin and those of purely igneous origin.

The metamorphism of some of these igneous rocks has been so extreme that they have become mica and garnet gneisses or schists that are indistinguishable from similar foliated rocks of sedimentary origin. Diorite

and many basic igneous rocks have become hornblende gneiss, hornblende schist, chlorite schist, serpentine, soapstone, etc.

The igneous rocks of the Piedmont Plateau include a wide range of such rocks as are generally classed as granite, diorite, gabbro, pyroxenite, peridotite, porphyries, and diabase, with many intermediate varieties. Some have been intruded as batholiths, laccoliths, sills, dikes, or stocks; and others have been poured out as surface flows. The eruptions occurred during several epochs. The older intrusives have been more or less metamorphosed and, as stated above, are not everywhere sharply distinct from the metamorphosed volcanic and sedimentary rocks.

The strike of the formations of the Piedmont Plateau is generally northeast, or approximately parallel with the trend of the plateau and the bordering Appalachian Mountains, but locally the strike may be nearly at right angles to the prevailing trend. The dip of the formations is generaly high but is variable, and as a rule it is southeast.

Kings Mountain District

The district here described contains both metamorphic and igneous rocks, and the metamorphic rocks include some of sedimentary and some of igneous origin. In age the rocks range from Archean to Triassic. The Archean rocks occupy most of the district, especially its northwestern and southern parts. Through the middle of the district from southwest to northeast extends a belt of probably Cambrian rocks, including schists, quartzites, conglomerates, and marble, and of probably Algonkian rocks, including schists and tuffs. The Archean rocks have been cut by masses of later igneous rocks—granites, diorites, etc.—some of which are of great size. The diorite and one body of granite are pre-Cambrian; two other granite masses are late Paleozoic, perhaps Carboniferous. The formations that are associated with the tin deposits are the Carolina gneiss and Roan gneiss, of Archean age; the Bessemer granite, of pre-Cambrian age; the Whiteside granite and, especially, tin-bearing pegmatites of late Paleozoic age. The other formations represented in the district are not associated with the tin ores and will not be considered here.

STRUCTURE

The rocks of the district have been extremely folded, to some extent faulted, and greatly metamorphosed. The structural features resulting from extreme compression run in general northeast, as is usual in the Appalachian Mountains and Piedmont Plateau. The Cambrian (?) and Algonkian (?) rocks lie in a corrugated synclinal trough between uplifted belts of Archean gneisses and later granites. This trough is

double, having two major downfolds, between which pre-Cambrian rocks reach the surface. In the Archean rocks along the northwest side of this general trough, at distances of 2 miles or less from their border lies the tin belt. In the area between Kings Mountain and Gaffney this boundary between the Cambrian (?) and Archean rocks coincides with a fault that dips about 45° NW. The folds of the rocks in the tin-bearing belt range in trend between N. 60° E. and N. 20° E. and are comparatively regular and straight, as are also the folds of the Cambrian (?) and Algonkian (?) formations. On both sides of this middle belt there are many and great local departures from this regular structure. In the tin belt the rocks dip northwest at various angles, usually high. Most of the minor folds are closed and overturned and are very difficult to detect. The faults, doubtless numerous, are likewise obscure, and comparatively few have been traced. The only one known to have affected the tin belt is the boundary fault mentioned above.

Carolina Gneiss

Distribution.—The Carolina gneiss, so named because of its extensive development in the Carolinas, is the most widespread formation in the district, as well as the oldest rock in the region. It is most prominently developed in the northwestern part of the district, and no large body of it is known southeast of the middle syncline of Cambrian (?) rocks. It has been cut into elongated and irregular shaped bodies by masses of intrusive igneous rocks.

Character.—The Carolina gneiss consists of an immense series of interbedded gneisses and schists, prominent among which are mica gneiss and schist, garnet gneiss and schist, and kyanite gneiss and schist, with intermediate varieties and granitoid layers. Less abundant are gneisses and schists characterized by graphite or staurolite. Practically all the gneiss and schist contains quartz and mica, either muscovite or biotite, but rock that contains other minerals, such as garnet or kyanite, receives its name from these. Thus garnet gneiss or schist may contain either muscovite or biotite or both, quartz, feldspar, and numerous accessory minerals.

The mica gneisses and schists are so diverse in texture and composition that it is difficult to give a general description of them. The schists range in texture from coarsely crystalline to fine grained and in many places exhibit variations both in grain and in mineral composition within a thickness of a few inches. Most of them are composed of quartz and biotite or muscovite, with or without feldspar, magnetite, and various other minerals. In some the mica scales are fine to medium in size; in others they are as much as a quarter of an inch in diameter. The

coarsely crystallized kinds are commonly associated with granite or pegmatite. The quartz and other minerals of the schists occur in aggregates showing about the same range in grain as the mica scales.

The schists are strongly foliated in consequence of the grouping of their mineral grains with their longer dimensions roughly parallel. The cleavage of the mica is parallel with the schistosity of the rock, and the scales wrap or fold around the ends of the other minerals or inclose lenticular masses of them. The quartz of the schists occurs in flattened or lenticular aggregates of small grains. These lentils may be separated or connected by small seams of quartz.

The structure of the schists renders them fissile, cleavage readily taking place both between the different mineral grains and through the more cleavable minerals, such as mica. In some schists cleavage in more than one direction has been developed by compression of the rocks in more than one period and in different directions. In some rocks the later cleavage, or "slip cleavage," is due to a parting or slipping developed along a series of small, close folds. In places mica scales have been formed along such slips, so that the structure closely resembles the original schistosity. Another variation in the mica schists is due to the development of scattered coarse mica crystals with the cleavage turned about at right angles to the schistosity. Such crystals have been developed by metamorphism later than that by which the schistosity was produced.

The mica gneiss of the Carolinas is varied in texture and composition. In one sense it may be considered as composed chiefly of a large variety of interlayered schists, the gneissic structure being due to the association of numerous unlike layers. A portion of the Carolina gneiss, however, is composed of granitoid layers that consist of feldspar, quartz, and either or both muscovite or biotite with numerous accessory minerals. The texture of this variety is commonly much coarser and the foliation less pronounced than in the mica schists. Some of this gneiss has developed from homogeneous rocks and consequently has a rather uniform texture and banding. Other masses have been derived from rocks of diverse composition and consequently show strong banding with contrasts in texture.

The ordinary gneisses and schists grade into other kinds by the addition of such minerals as garnet, kyanite, and graphite. Where garnet and kyanite are abundant and occur in large crystals the texture of the schists differs substantially from that of ordinary mica schist. Garnet and kyanite tend to crystallize with but little adaptation to the parallel arrangement of the other minerals of the schists and accordingly pro-

duce a porphyritic texture. Graphite, however, occurs in plates or scales parallel with the mica, and its presence does not change the general texture of the schists.

The interlayering of and gradations between mica schists and gneisses and those containing garnet and kyanite are so prevalent and intimate that it is practically impossible to show all varieties separately on a map.

Roan Gneiss

Distribution and name.—The Roan gneiss, named from Roan Mountain, on the North Carolina-Tennessee border, where the formation is extensively developed, occurs in large masses and in belts or dikelike bodies cutting the Carolina gneiss in practically the whole of the district. It forms most of the surface at the south border of the district, and in the north-central part it occurs in areas 2 to 5 miles wide, most of which have very irregular outlines, especially near the intrusive bodies of Whiteside granite.

Character.—The Roan gneiss consists chiefly of hornblende schist, hornblende gneiss, schistose diorite, and diorite. In places there are intercalated layers of mica schist and gneiss and garnet schist and gneiss not essentially different from similar rocks of the Carolina gneiss. The hornblende beds are black or dark greenish black in color, and the other schists are light to dark gray. The hornblende rocks are of uniform composition, even in rather large bodies. Massive diorite occurs in some of the larger masses of Roan gneiss, but most of the rock is somewhat schistose. Very schistose varieties that are apparently composed almost wholly of hornblende are called hornblende schist but are as a rule merely modifications of the diorite. In places hornblendic layers are separated by layers of quartz or feldspar, and the rock is designated hornblende gneiss. The hornblendic rocks range from those of fine texture to those in which some of the crystal grains measure half an inch across. The mica and garnet gneisses and schists within the Roan gneiss are probably masses of the Carolina gneiss included in the original diorite at the time of intrusion or subsequently interfolded with the Roan gneiss. Pegmatite occurs through much of the Roan gneiss, as in the Carolina gneiss.

Bessemer Granite

Distribution and name.—The Bessemer granite crops out in several broad bands in the central part of the district. The main band lies southeast of the general central trough of Cambrian (?) sedimentary rocks, and smaller bodies of the granite appear between its two main

parts. One of these minor bodies expands to the north and in the Lincolnton quadrangle underlies Bessemer City, for which it is named.

Character.—The Bessemer granite is a medium to fine grained muscovite biotite granite near quartz monzonite in composition. It is locally porphyritic. In all outcrops it has a strong schistose structure, and in many places it has been metamorphosed into white and gray quartz sericite schists that bear no resemblance to the original granite. Only in certain favorable outcrops can the gradation from the schistose granite to sericite schist be seen. The porphyritic varieties of the granite have in some places been metamorphosed into quartz-augen sericite schists or "bird's-eye" schists.

In the less altered parts of the granite the constituent minerals are quartz, orthoclase, oligoclase, muscovite, biotite, and a little magnetite and zircon, with secondary clinozoisite and chlorite. In the metamorphism of the Bessemer granite to quartz sericite schists the muscovite has been largely recrystallized into finer scales and the potash feldspar has passed into fine scaly sericite. The quartz has in part recrystallized, but the larger grains or phenocrysts retain more nearly their original size and position. Much silica has been set free in alteration during metamorphism and deposited in the form of quartz veins cutting the sericite schists. The Bessemer granite yielded more easily to processes of metamorphism than the granitic rocks of the Carolina gneiss.

Pegmatite

Pegmatite is abundant in the area of Archean rocks, and a few small deposits have been observed in other formations. The rock is variant in composition but normally is composed chiefly of feldspar and quartz, with or without mica and other minerals. In some varieties feldspar is practically absent, and the pegmatite is composed chiefly of quartz and mica. Pegmatite is allied to granite in composition but is of more varied and much coarser texture. In some of it individual minerals may measure more than a foot across.

The pegmatite occurs in sheets, lenses, and irregular masses ranging in thickness from a few inches to many yards and attaining half a mile in length. These masses may follow the bedding or the schistosity of the country rock or may cut across them at various angles. Most of the deposits are too small to be shown on any ordinary geologic map, but some of the larger ones and those of special interest because of their mineral associations have been mapped and will be shown in the folios describing this district, which are now in preparation. A few of the pegmatites have a pronounced schistose structure, but most of them are

massive. Some of the pegmatites are probably of Archean age, but the majority are probably younger and are genetically connected with post-Cambrian granite intrusions, especially with the Whiteside granite. The mineral composition and variations of the pegmatites are given in considerable detail in the descriptions of the mines and prospects (pp. 135-146).

Whiteside Granite

Distribution.—The granite of this region that has been correlated with the Whiteside granite of the Pisgah and other quadrangles to the west covers large areas of the Kings Mountain district. It has been observed at many places in the region between this district and the Pisgah quadrangle, and it has been mapped in the Morganton, Mount Mitchell, and Saluda quadrangles of North Carolina. The name is taken from Whiteside Mountain, in the Cowee quadrangle, west of the Pisgah quadrangle, where the granite crops out in tremendous cliffs. Because of its relations to the associated rocks, the Whiteside granite is considered to be of later age than Cambrian, and possibly it was intruded during the mountain building period at the end of the Carboniferous.

Character.—The granite is composed chiefly of orthoclase, microline, and oligoclase feldspar, quartz, muscovite and biotite mica, and such accessory minerals as magnetite, apatite, and zircon. Minerals of secondary development are garnet, epidote or zoisite, chlorite, and kaolinite. The feldspars are the predominant minerals and the micas the most variable in abundance. Muscovite is more plentiful than biotite. Garnet is plentiful in some parts of the granite, especially those which have received a schistose structure through metamorphic processes; in some of these the garnets measure a tenth of an inch in diameter.

The granite is generally of light gray color, and those varieties in which biotite is scarce are nearly white. Most of it has a medium to fine grain, especially in the smaller masses. In some places it shows a porphyritic texture, as in parts of the mass in the northeast corner of the Lincolnton quadrangle. The porphyritic forms appear much coarser grained because of the considerable size of the feldspar phenocrysts. Variations occur in different parts of the same bodies of the granite, some showing porphyritic phases and others the more even grain characteristic of the greater part of the Whiteside granite.

The Whiteside granite has yielded to metamorphism to varying degrees. In many places there is a gradation from typical granite in the interior of a mass to strongly schistose or gneissic granite at the border. The bulk of the granite shows only moderate metamorphism.

In places the Whiteside granite exhibits flow banding marked by an arrangement of minerals in roughly parallel layers. This structure may have developed in two ways, either during the intrusion of the granite magma in which a partial segregation of the minerals had already taken place or by the mashing and flowing under pressure of granite which contained partly absorbed masses of other rocks. These processes have yielded rocks characterized by discontinuous irregular wavy bands of different minerals. The flow structure may be present in one part of a granite mass and absent in another a few feet distant.

Relations.—The Whiteside granite is intrusive into all the rocks with which it is in contact in these quadrangles except the Triassic diabase dikes. Intrusive relations are shown by the doming action of batholiths, from the borders of which the layers of gneiss dip away at various angles, by the inclusion of masses of the gneisses with which it is in contact, by the occurrence of dikes both conformable with and cutting across the layers of the inclosing gneisses, and by the relations of the granite to pegmatite that cuts other rocks.

The best illustration of batholithic intrusion is around Cherryville, where the Whiteside granite has invaded the gneiss as a great batholith and also as sills, especially to the southwest of the main mass. The interlayered masses of gneiss and granite dip away from the main mass of granite to the south and southwest.

Sill-like dikes of the granite are abundant in the gneisses, especially near the batholiths, and in some places these dikes branch out or turn across the schistosity, cutting from one layer to another.

Irregular bodies of pegmatites occur in the granite and extend from it out into the surrounding rocks. The texture of these pegmatites varies from extremely coarse to that of a coarse granite. In places pegmatite appears to grade into the granite. The invariable association of the pegmatite with the granite and the gradation of the one into the other show that they are related in origin. In places the gneisses and schists have been intruded by dike after dike of granite and injected by so much pegmatite that, with the unsatisfactory outcrops in this region, it is impossible to determine which rock is the more abundant, the original gneiss or the granite and allied pegmatite.

Inclusions.—Within the Whiteside granite are included numerous masses of the rock intruded by it, but this relation is best exhibited where the hornblendic rocks of the Roan gneiss are intruded by the granite, especially in a large area 3 to 5 miles south of Cherryville, in the Lincolnton quadrangle. Many of the inclusions have been more or less absorbed by the granite magma, which they have changed in composition. The absorption of the schists of the Carolina gneiss has yielded

streaks of highly micaceous granite grading into highly micaceous schist. When they were intruded the hornblendic formations were broken up into more blocklike bodies, which floated out into the granite magma. Such inclusions were more or less dissolved by the inclosing magma, so that the magma became more basic near them. Thus the composition of the granite may be changed over considerable areas, and gradations occur from diorite inclusions seemingly to quartz diorite, to hornblende-biotite granite, to granite rich in biotite, and to the normal Whiteside granite.

The Tin Deposits

General Features

Distribution.—The presence of cassiterite, oxide of tin, at many places in the Kings Mountain and Lincolnton quadrangles, at one place near Gaffney, in the Gaffney quadrangle, and at one locality in the Gastonia quadrangle has led to much prospecting and to attempts at mining. In at least one place—the Ross mine, near Gaffney—placer mining was temporarily done at considerable profit. Several prospects have also been opened in the Lincolnton and Gastonia quadrangles north and northeast of the Kings Mountain quadrangle. Practically all the work on cassiterite-bearing veins has been done at a loss, but this work has not been sufficiently conclusive to prove or disprove the value of some of the deposits.

The cassiterite deposits have been found in a belt extending from a point 2 miles northeast of Grover, about parallel with the general trend of the rock formations, through the town of Kings Mountain and northeastward to Beaverdam Creek, 6 miles from Lincolnton. So far as known the Ross tin mine, near Gaffney, is on an isolated deposit, but this lies in about the same belt of rock formations as those between Grover and Kings Mountain.

Inclosing rocks.—The tin deposits occur in pegmatite masses within Archean rocks, either the Roan gneiss or the Carolina gneiss along or near its contact with the Roan gneiss. The belt of deposits lies within a mile northwest of the belt of Cambrian(?) rocks in the Gaffney and Kings Mountain quadrangles. To the north, in the Lincolnton quadrangle, the tin deposits diverge more widely from the Cambrian (?) rocks, but in the Gastonia quadrangle, east of the Lincolnton, they approach those rocks again.

The rocks inclosing the pegmatite are hornblende schist, hornblende gneiss, diorite, mica schist, and mica gneiss, with or without accessory garnet and kyanite. These formations have steep dips along the tin belt.

Occurrence of pegmatite.—The pegmatite occurs in sheets and lens shaped bodies cutting the gneisses and schists. Some of the pegmatite masses are conformable with the structure of the inclosing schists, but others cut across the schist layers with various dips and strikes. Inclosed in the same formations are many other pegmatite bodies which are more or less similar to those bearing cassiterite but in which this mineral has not yet been found.

There are great variations in mode of occurrence and character of the pegmatite of the tin belt, including those which contain cassiterite. The masses range from less than an inch to 100 feet in width and from a few inches to probably more than half a mile in length. Some are only little longer than they are wide; others occur as large thin sheets. Some of the pegmatites occur in more or less parallel position, others in a belt with overlapping ends or in line with one another, and others lying at various angles with one another. The occurrence, where exposures are poor, of several bodies of pegmatite lying parallel and a few feet apart has misled some observers in estimating the width of some of the deposits. The pegmatite masses may fork or have connecting branches. They may turn, swell, pinch out abruptly or taper down at the ends. These variations may occur in different planes. Some of the pegmatites are more regular than others and hold one direction of strike or dip for considerable distances. The greatest irregularities occur in those bodies which cut across the schists or gneisses, or in those which branch from deposits otherwise conformable with the schistosity of the inclosing rock.

Origin of pegmatite.—The relations of the pegmatites to the inclosing rocks are chiefly those of intrusives, modified in some places by the action of solutions or gases. It is possible that some of the pegmatites have been deposited from aqueo-igneous solutions, but probably the majority, especially of the larger massive deposits, were mass intrusions. To which class many of the different pegmatites belong is a matter of uncertainty. Both types are supposed to be the products of granitic magmas that contained an excess of water and possibly gases and other mineralizing agents under conditions of heat and pressure. In the crystallization of a granite magma water is expelled and in part accumulates in the portion of the magma that remains unsolidified. This remaining magma accordingly becomes more fluid and may be regarded as an extremely hot concentrated aqueous solution. The expulsion of this liquid magma or solution into surrounding rocks gives rise to masses of pegmatite, which grade between typical dikes and typical veins.

Composition of pegmatite.—The pegmatites of the tin belt, including those that carry cassiterite, are somewhat diverse in composition. Some

are composed of the usual minerals, feldspar, quartz, and mica, without appreciable quantities of other constituents. Others carry spodumene and cassiterite. Cassiterite occurs both in pegmatites which contain spodumene and in those which do not. The other minerals observed in the cassiterite-bearing pegmatites are few and not important. Such minerals as wolframite and arsenopyrite, which are associated with tin ore in other regions, appear to be absent here. The variations in composition consist chiefly in variations in the proportion of the different minerals present. In some deposits feldspar predominates; in others quartz; in some mica is absent and in others abundant.

Great irregularities occur in the distribution of the minerals. Quartz is segregated into large separate masses in some deposits and mixed through the rock in coarse grains in others. Cassiterite in small deposits occurs in scattered grains through one part of the pegmatite body and is absent a number of feet distant in another part. In some of the large pegmatite bodies the cassiterite is irregularly scattered through large masses of the rock, and in others it occurs more or less irregularly concentrated along one wall of the pegmatite as a smaller vein but connected with the main mass. In some of the pegmatites rich in cassiterite, feldspar is only sparingly present if at all. This kind of deposit, then, has the nature of greisen and has been observed as lenses or streaks in larger bodies of pegmatite and along the contacts of such bodies with the inclosing rocks.

The cassiterite appears to have been one of the first minerals in the pegmatite to crystallize. Its boundaries are sharp, although crystal outlines are rather rare. Nowhere has a gradation between cassiterite and quartz or feldspar been observed, as there would be if the cassiterite had been introduced by metamorphism after the pegmatite was formed; nor are there inclusions of other minerals in the cassiterite. Accordingly it seems clear that the cassiterite was an original constituent of the pegmatite—a view which has already been stated by Graton. In some places the concentration of the cassiterite in greisen along the pegmatite border indicates metamorphic action, during which there were mutual reactions between the dike and the wall rock. The cassiterite, the earliest mineral to crystallize, formed first near the wall. The reaction of wall rock and dike is also evident by the unusual coarseness of the mica schist of the wall in many places.

Age of tin deposits.—The rocks in the tin belt are of two classes—(1) the gneisses, etc., of Archean age, and (2) the granites, pegmatites, and quartz veins, which cut the Archean rocks. The Archean rocks are greatly altered by deformation, but the younger rocks show little or no alteration. The Whiteside granite was locally rendered schistose but for

large areas is massive and unaltered. It is therefore concluded that most of that granite is younger than the mountain-building movements which deformed and altered this entire region. This conclusion assigns to the Whiteside granite a late Carboniferous age. Similar reasoning assigns a late Carboniferous or post-Carboniferous age to the pegmatites and quartz veins.

It seems probable that granite, pegmatites, and quartz veins form a cycle, the granite having invaded the Archean rocks nearly at the end of the Carboniferous period, the pegmatites representing a later stage of intrusion, partly in mass and partly by permeating solutions, and the veins being the final products of the cooling magma. The general distribution of the rocks favors this view, for the tin-bearing pegmatites are not in the granite but are near its general southeast margin, while the quartz veins, more or less mineralized, occupy a general belt southeast of and farther away from the granite.

Mines and Prospects

Gaffney Quadrangle

Ross Mine

The Ross tin mine is about 1½ miles northeast of Gaffney, on the northwest side of a small hollow that drains northeastward into a tributary of Providence Branch. The work consists of many open cuts and placer washings, pits, and trenches, and a shaft more than 130 feet deep, with levels, all within a space about 600 feet long from northeast to southwest and 100 feet wide. Placer mining has been done on the lower part of the slope, where water was available, and material obtained above this place has been carted down to the sluice boxes. In this way the greater part of the hill slope from a point near the shaft northeastward to the branch, a distance of about 400 feet, has been worked over.

The shaft and underground workings were not accessible at the time of visit, but portions of the vein were exposed in shallow workings, and these, with descriptions by Sloan and Graton, furnish material for the notes here given. A crosscut was driven from the shaft northwest to the vein on the 63-foot level, and winzes were sunk on the vein from this level to the 90-foot level and there connected by a drift. The shaft cuts the vein at a depth of nearly 100 feet.

The placer material consisted both of weathered vein material approximately in place and of hillside débris derived from the vein. Where the loose material only was washed, the work was carried only a foot or two deep, but where the weathered outcrop of the vein constituted the placer material, excavation was carried to depths of more than 10 feet.

The country rock consists of interlayered hornblende schist and fine biotite gneiss, probably belonging to the Roan gneiss. These rocks strike about northeast, and dips were measured ranging from 25° SE. in the branch to 60° SE. in the mine workings. Along the stream the rocks are only slightly altered, but in the underground workings the saprolite was found to extend to depths greater than 60 feet, passing gradually into less altered rock. From the lower workings hard, fresh wall rock was brought up but the vein material is partly altered to the bottom of the mine. The wall rock on the dump consists of rather coarse hornblende schist and garnetiferous biotite gneiss. The pegmatite in the upper workings is decomposed by Kaolinization of the feldspars. Specimens examined from the lower workings are hard, compact, and schistose and contain an abundance of compact fine sericite or pinite and a fibrous mineral like sillimanite. Under the microscope were observed partly sericitized orthoclase, oligoclase, muscovite and sericite, sillimanite, cassiterite, a prismatic mineral that is probably staurolite, and iron ore.

In the upper workings the streaks of hornblende schist have weathered to dark yellowish-brown saprolite and the mica and garnet gneiss to dark-grayish saprolite. The pegmatite is represented by masses of white kaolin and a little intermixed quartz with some mica.

The cassiterite-bearing pegmatite occurs as a series of irregular sheets and lenses approximately conformable with the inclosing gneiss and schists—that is, it has a northeast strike and a dip of 50°-60° SE. The train of pegmatite bodies, or "vein," is from 1 to nearly 10 feet wide, and the individual masses measure from less than an inch to 4 feet in width. The tin content varies widely. Graton mentions a 100-pound sample taken across a pegmatite body on the 75-foot level which contained 9 pounds of cassiterite, or about 6.5 per cent of metallic tin.

Most of the ore taken from the Ross mine was decomposed and soft and could be readily concentrated in sluice boxes. The ore taken from the lowest workings, however, was hard and would require crushing before concentration. The concentrates obtained have generally averaged over 65 per cent metallic tin. Sloan states that the total shipments of cassiterite concentrates from the Ross mine to 1906 amounted to about 130 tons. The shaft was sunk to its present depth in 1907. Since that time only a little surface testing with some sluicing has been done, resulting in a production of a few thousand pounds of concentrates.

Kings Mountain Quadrangle

Localities

Twenty or more places in the Kings Mountain quadrangle have been prospected for cassiterite. During 1907 the Blue Ridge Tin Corpora-

tion worked in the town of Kings Mountain and at several places southwest of the town along a line of prospects opened by Ledoux & Co. in 1888 and 1889. A promising prospect on the Faires place was tested by Capt. S. S. Ross and others, of Gaffney. Named in order from the North border of the Kings Mountain quadrangle to the south and southwest some of the mines and prospects are: The old Blue Ridge Tin Corporation mine, on the west side of the railroad tracks in the town of Kings Mountain; Mrs. Elizabeth Falls's prospect, two-thirds of a mile south of the town; the Faires prospect, eight-tenths of a mile west of south of the town; prospects tested by the American Tin Plate Co., adjoining the Faires prospect on the southwest; the Mike Plonk prospect, 1¼ miles southwest of the town; a series of openings made by Ledoux and Co., beginning 1½ miles southwest of the town and extending one-third of a mile southwest along a ridge; an old prospect opened by Ledoux & Co., 1¾ miles southwest of the town; the principal workings of the Blue Ridge Tin Corporation, 2 to 2⅛ miles southwest of the town, consisting of two shafts, drifts, and some placer work; three prospects of the Blue Ridge Tin Corporation, beginning west of the placer ground and within half a mile to the southwest; other prospects to the southwest and one two-thirds of a mile southeast of Crocker opened by Capt. Ross in 1903. Still other prospects farther southwest are reported but were not examined. Float tin has been found at other places in the town of Kings Mountain and along the belt southwest of the town.

Kings Mountain Mine

At the Kings Mountain mine of the Blue Ridge Tin Corporation three shafts were sunk from 50 to 75 feet deep and some drifts run from them. Two of the shafts were about 50 feet apart and near the railroad tracks. A mill for treating the ore was erected close by. The third shaft is about 150 feet west of the mill and on a different "vein." The workings were not available for examination at the time of visit and little could be learned of the result of the operations. Rich ore was found in pegmatite débris on the surface and similar rich ore was reported from parts of the underground workings.

The country rock is strongly folded coarse mica schist with a body of similarly folded hornblende schist less than 100 feet to the south. The strike of the schistosity of these rocks is north to west of north and the dip about vertical, but the contact of the two formations runs as a whole nearly east, although jagged in detail. This is due to rather close folding with a strong northward pitch in the folds. The cassiterite-bearing pegmatites are nearly conformable with the schistosity of the inclosing rocks, and the ore shoots would probably be found to pitch northward in

conformity with these folds. The pegmatites are variable in width, ranging from less than a foot to several feet as exposed near the collar of the western shaft. Most of the pegmatite, especially that rich in feldspar, is weathered and soft in the upper part of the workings, but some of the greisenlike ore rich in cassiterite is but little altered, even at the surface.

Cassiterite-bearing pegmatite crops out about 150 yards southeast of this mine in the gutter of one of the side streets of Kings Mountain and is reported to have been found in a well about 300 yards farther south. A number of loose cassiterite crystals were found one-third of a mile west of the railroad on both sides of the street leading toward Shelby.

Falls Prospect

The Falls prospect is on the east side of a small hollow in the south part of the town of Kings Mountain. It was tested a number of years ago by trenching along the hillside and sinking some shafts. Large pegmatite bodies were exposed in the hillside workings, but little cassiterite was found in them. A shoot of rich greisen was found in a shaft on top of the hill east of the trenches. Here the cassiterite-bearing greisen formed a pocket or shoot about 2 feet wide in a body of pegmatite about 8 feet wide. The pegmatite is inclosed between chlorite schist on the northwest and mica schist on the southeast. A ledge of tourmaline quartz rock crops out in the branch about 75 yards southeast of the place where the tin lead crosses it. This ledge is composed of gray to smoky quartz penetrated by a large number of long, thin crystals of black tourmaline. In some parts the tourmaline composes about half of the vein.

Faires Prospect

Development work on the Faires property, a quarter of a mile southwest of the Falls prospect, consists of several pits and a 40-foot shaft with 200 feet of drifts, now badly caved in. A 10-foot pit at a place where rich float was found exposed a cassiterite-bearing pegmatite dike 3 feet wide striking N. 30° E. with a high northwest dip. The vein was cut on the 40-foot level by a crosscut from the shaft on the southeast. Here the pegmatite, it was reported, is about 3 feet thick and carries cassiterite. A drift to the northeast showed the pegmatite to be wider and to carry more cassiterite. Another pegmatite dike was prospected 33 feet southeast of this "vein" but did not carry cassiterite. The pegmatite from the underground workings is badly decomposed, most of the feldspar being kaolinized. The parts richest in cassiterite contain less feldspar and are harder. Some of the ore taken out was very rich, and in one section exposed the rock was estimated to carry about 10 per cent

cassiterite. The country rock is hornblende schist, badly decomposed. A tourmaline quartz vein is inclosed in the schist a few yards southeast of the pegmatite.

Other prospects were opened southwest of the main workings, on other outcrops of pegmatite. Cassiterite was found in some of these also, and in one of the exposures appears to be in promising quantity. About 300 or 400 yards southwest of the main deposit a large body of spodumene-bearing pegmatite over 40 feet wide crops out prominently in the north side of a small valley. No cassiterite was observed in this rock. Similar outcrops of spodumene-bearing pegmatite occur within half a mile to the southwest, but most of them lie northwest of the belt in which tin ore has been found.

Plonk Prospect

On the Plonk property a long trench was cut across the formations, exposing both spodumene pegmatite and cassiterite-bearing pegmatite inclosed in hornblende schist. The formations strike N. 35° E. and dip 75° NW.

Old Ledoux Prospects

Considerable prospecting has been done along the ridge adjoining and to the southwest of the Plonk property, first by Ledoux & Co. in 1888 and 1889 and later by the Blue Ridge Tin Corporation. At the northeast is an old crosscut trench, where little is to be seen at present. Next is a trench about 200 feet long and 5 to 20 feet deep along the east contact of a large pegmatite. At the surface the contact strikes N. 25° E. and dips 80° NW., but at a depth of 20 feet the dip is 60° NW. Coarse garnetiferous mica schist forms the footwall of the pegmatite. Cassiterite was found in a greisen-like phase of the pegmatite along the footwall. The cassiterite-bearing portion is from 1 to 3 feet wide and is rich in some places and poor in others. It is reported that a vertical diamond drill hole bored over 100 feet west of the "vein" cut 5 feet of ore at a depth of 275 feet. The pegmatite dike at this place is probably at least 25 feet wide. To the northwest are other large masses of pegmatite separated from one another by several feet of schist. These bodies do not crop out distinctly, and pegmatite bowlders have rolled between them, giving an appearance of one large deposit several hundred feet wide. Some of them carry considerable spodumene but apparently no cassiterite. The cassiterite-bearing mass is inclosed in mica schist, but most of the other masses are in hornblende schist.

About 50 yards southwest of the long trench a shaft 85 feet deep, called No. 1 by the Blue Ridge Tin Corporation, was sunk near a pit where good ore had been found. A 60-foot crosscut from the shaft cut three "veins," one of which carries cassiterite. These pegmatite veins

are in interlaminated hornblende schist and garnetiferous mica schist. Further southwest is a trench 100 feet long and 3 to 12 feet deep on a contact similar to that just described. This contact strikes about N. 25° E. and dips 80° W. Cassiterite was found in part of this trench, and some of the material was promising looking ore. A short distance to the southwest two shafts have been sunk, one on spodumene pegmatite. Cassiterite was reported in both of these shafts.

Near the end of the ridge a trench was made along the southeast contact of another large body of spodumene-bearing pegmatite, which carries cassiterite along the southeast wall. The wall rock on this side is chloritic mica schist.

About 200 yards west of this trench, on a knoll across a small valley, is another old shaft, 60 feet deep, in a large pegmatite dike carrying spodumene. A little cassiterite was found at this place and also at another pegmatite outcrop opened by two pits about 200 yards southwest. The inclosing rock is hornblende schist at both of these prospects.

Blue Ridge Tin Corporation Main Works

At the northeast end of the outcrops on the property of the Blue Ridge Tin Corporation a shaft 80 feet deep (No. 4) was sunk, with a 60-foot drift to the southwest on the 60-foot level. A 20-foot prospect shaft was sunk south of the main shaft. Two "veins" were found—one in the 20-foot shaft and the other along the northwest side of the drift on the 60-foot level. The material of these "veins" consists of schistose greisen-like pegmatite and is reported to be badly crushed in the underground workings.

About 200 yards to the southwest is shaft No. 5, 130 feet deep. Underground workings cut two "veins" carrying cassiterite. One of these veins that crops out 15 feet southeast of the shaft was cut a few feet from the shaft in a crosscut to the southeast on the 85-foot level and in the shaft near the bottom. This "vein" is said to contain fine grained ore at the surface but coarser ore underground. The outcrop of the other vein was not found, but the ore was cut in the crosscut on the 85-foot level. It is said to have been coarse grained and rich ore. Another cassiterite-bearing pegmatite body was opened by a 25-foot shaft about 60 yards west of the main shaft.

A large spodumene pegmatite mass about 15 feet wide crops out between shafts No. 4 and No. 5. Débris of cassiterite-bearing pegmatite or greisen was found near this mass, and a little cassiterite was observed in the spodumene-bearing part.

The country rock at these workings consists of interlaminated hornblende schist and bluish mica schist having a northeast strike and high to

nearly vertical northwest dip. The "veins" seem to be at least approximately conformable with the inclosing schist.

Placer deposits have been worked in the bottom land along the valley southwest and south of the mine. The ground favorable for this work is from 50 to 100 yards wide at the lower end and tapers northwestward to shoals where the tin lead crosses the stream. It has a length of over 200 yards. Water is available, and parts of the placer ground are reported to have been tested with encouraging results. At one time some of the alluvial material was hauled up an incline track to a concentrating mill on the hillside, but although several thousand pounds of concentrates were washed out the work was not profitable with such equipment.

On the hill on the southwest side of this same valley a 25-foot shaft was sunk and a 10-foot crosscut run. A body of spodumene pegmatite, 5 feet wide, was found inclosed in hornblende and chlorite schist. A little cassiterite is reported to have been taken out. In two prospects within half a mile southwest similar spodumene-bearing pegmatite masses were opened. They are in hornblende and chlorite schist. Cassiterite is reported to have been found in both. A mass of tourmaline quartz rock occurs about 10 feet southeast of one of these pegmatite masses.

Ross Prospect

At the old prospect two-thirds of a mile southeast of Crocker, opened by Capt. S. S. Ross in 1903, a pit was sunk on the southeast side of a body of pegmatite about 20 feet wide. This pegmatite is said to contain considerable cassiterite in a streak several inches thick along the southeast wall but only a few scattered grains within the mass. Bluish mica schist forms the wall rock, but 45 feet to the southeast there is a belt of hornblende schist. A vein of tourmaline quartz is inclosed in the hornblende schist about 50 yards southeast of the pegmatite.

Lincolnton Quadrangle

Prospects Along Chestnut Ridge

The Mauney Park prospect is on the south side of a small valley cutting eastward across Chestnut Ridge, about one mile north of the north edge of the town of Kings Mountain. The deposit is near some springs which have been walled up and around which the grounds have been cleared as a park. It was discovered by the presence of a number of bowlders of greisen, rich in cassiterite and weighing from 30 to 150 pounds each, loose in the surface soil. A small amount of prospecting was done during the "tin excitement" of 1904. This work consisted in clearing out undergrowth and digging pits and a crosscut trench. The

pits are on the north side of a small ridge pitching east and the trench is on the south side of the ridge, 65 yards due south of the pits.

The country rock consists of kyanite mica schist and gneiss with a narrow belt of hornblende schist close to the tin bearing pegmatite. The schists strike north and have a vertical dip, and the pegmatite is approximately conformable with them. The pegmatite exposed in one of the pits is nearly 8 feet wide. Of this width 2 feet along the west wall consists of cassiterite-bearing greisen. The remaining 6 feet of pegmatite is highly feldspathic and carries but little cassiterite. This portion of the dike is soft and crumbling owing to the kaolinization of the feldspar. The feldspar free greisen portion is fresh and hard and shows a few iron oxide and clay stains. Part of the greisen is rather fine grained, and part is coarse containing muscovite crystals an inch across. In places at least 10 per cent of the greisen is cassiterite, some of which occurs in crystals an inch long and half an inch thick.

Pegmatite was cut in the trench on the south side of the ridge, apparently in direct line with the cassiterite-bearing pegmatite on the north side. No cassiterite was observed at this place, however. From 20 to 30 yards east of this an outcrop of spodumene-bearing pegmatite extends in a west of north direction across the ridge. No cassiterite was seen in the prospects opened on this spodumene pegmatite.

Cassiterite-bearing greisen is found in a cultivated field a quarter of a mile due north of the Mauney Park prospect, on the west side of Chestnut Ridge. Bowlders of this rock have been plowed up, but no prospect work has been done.

The Horton shaft, 122 feet deep, was sunk in 1893 on the east side of Chestnut Ridge half a mile northeast of the Mauney Park prospect by residents of Kings Mountain. Crosscutting was started, and cassiterite-bearing pegmatite is reported to have been found. This prospect is not in line with the Mauney Park lead but is in line with other prospects on the east side of Chestnut Ridge and east of Long Creek Church. At one of these, on the land of J. J. Ormond, a quarter of a mile east of the north end of Chestnut Ridge, cassiterite-bearing greisen was found in surface bowlders and in a prospect shaft. A little cassiterite has been found between the Horton shaft and the Ormond prospect along the east side of Chestnut Ridge.

Ormond-Carr Prospect

The Ormond-Carr prospect is a quarter of a mile east of Long Creek Church. A shallow shaft and a few pits were made in a north-south direction along an outcrop of pegmatite. The country rock is hornblende schist of the Roan gneiss. A narrow belt of staurolite schist crops out a few yards east of the deposit. The formations strike about

north and have a high westerly dip, and the pegmatite is approximately conformable with them. The pegmatite exposed is from 5 to 8 feet wide and carries cassiterite in places.

Hovis Prospect

The M. V. Hovis prospect is 1⅜ miles N. 12° E. of Long Creek Church. Cassiterite is found in loose crystals and in small bowlders of greisen scattered over a field and along the public road. A 35-foot prospect shaft was sunk a few yards west of the road, and decomposed pegmatite was encountered in it, but no cassiterite was seen at the time of examination. The country rock is evidently chiefly hornblendic schist weathered to a dark-brown soil.

Ramseur Mill Prospect

The Ramseur Mill prospect is about a third of a mile east of north of the Hovis prospect, or nearly 2 miles east of north of Long Creek Church. A shaft and a trench were made here during the first tin excitement, and some very promising cassiterite-bearing greisen was thrown out. The country rock is hornblende schist with varied strike and dip. The attitude of the pegmatite is not plainly evident, but the trench made along the northeast contact showed this to have a N. 30° W. strike. The pegmatite body is large, at least 15 feet wide, and crops out through a distance of about 75 feet. The cassiterite was found in a greisen streak 1 to 2 feet thick along the northeast wall.

Jones Mine

The Jones mine is about 3½ miles N. 30° E. of Bessemer City. It was first prospected in about 1892 or 1893, but the principal work was done between 1903 and 1904. The following description is partly taken from a report by Graton,[1] supplemented by notes of D. B. Sterrett. The early workings consisted of a shallow shaft and some pits on a pegmatite vein striking north of west with a nearly vertical dip. At one place this vein was 2½ feet wide and very rich in cassiterite. About 70 feet west it contained only a small quantity of cassiterite, and 70 feet still farther west cassiterite was absent.

Later work was rather extensive. Shafts and trenches were made along the vein first opened through a distance of about 200 feet. A shaft 175 feet deep was sunk about 150 feet N. 70° W. from the west end of the workings along this vein, and still another shaft 150 yards west of this. A second pegmatite vein 100 yards south of the first one was opened by prospect pits through a distance of about 100 yards in

[1]Graton, L. C., Reconnaissance of some gold and tin deposits of the southern Appalachians: U. S. Geol. Survey Bull. 293, pp. 46-48, 1906.

a northwesterly direction. In all, about 500 feet of underground work is reported to have been done. A small amount of placer mining was carried on in the branch east of the deposit. A mill was erected at the mine, and a carload of concentrates is reported to have been shipped.

The deposits occur near the contact of interlaminated hornblende schist of the Roan gneiss and mica gneiss of the Carolina gneiss. The strike of these formations ranges from east of north on the east side of the deposit to nearly west near the middle of the workings and northwest near the west workings. The dip ranges from 50° N. to nearly vertical. The first vein opened cuts across the bedding of the country rock, having a north of west strike and a nearly vertical dip. Along the contact of this pegmatite the mica gneiss contains a quantity of small black tourmaline crystals and needles. Pegmatite also occurs in small offshoots from the larger bodies and in lenses and stringers near them.

The pegmatite mass is variable in character. In some places it has about a normal mineral composition. In others the feldspar is subordinate, or almost absent, and cassiterite may or may not be present. Some of the pegmatite from the 175-foot shaft contains spodumene. Where cassiterite is plentiful the pegmatite does not carry so much feldspar, and in places where there is more than 10 per cent of cassiterite feldspar is practically absent.

Some of the richest ore was found in the vein first opened. A small sample of ore from the earlier workings yielded cassiterite equal to about 5 per cent metallic tin when crushed and panned. Graton states that the average of all the pegmatite broken in the mine is said to have been about 0.7 per cent of metallic tin.

Stroup and Rayfield Prospects

Prospects were opened in 1904 along the boundary line between the places of Nora Rayfield and John Stroup, 2½ miles S. 60° W. of Landers Chapel, but these pits are now filled up. The country rock is hornblende schist, and a belt of kyanite gneiss lies a few yards west of the tin deposits. Cassiterite-bearing pegmatite was found in the prospects, but only a few pieces of this ore, of medium grade, were left on the surface at the time of examination.

Hastings Prospect

The H. P. Hastings prospect is about half a mile northeast of the Stroup and Rayfield prospects, or 2 miles S. 65° W. of Landers Chapel. It was opened by a 14-foot shaft and a crosscut trench. Cassiterite-bearing pegmatite was found on the surface for a distance of about

100 feet in a northeasterly direction. The country rock consists of interbedded hornblende schist and kyanitic mica gneiss, which strike northeast and have a high northwest dip. The pegmatite is approximately conformable with the bedding of the inclosing rock. The ore is medium grained and carries a large percentage of quartz, a little feldspar, mica, and fine cassiterite.

Baldwin and Allen Prospects

The prospects of J. Baldwin and J. R. Allen are a third of a mile northwest of the Hastings prospect, or 2 miles S. 73° W. of Landers Chapel. They are on opposite sides of the public road, the Baldwin prospect about 80 yards southwest of the road and the Allen prospect about 150 yards N. 55° E. from the Baldwin prospect. A 45-foot shaft was sunk at the Baldwin prospect, and a few blasts were made in the outcrop. Two pits, now partly filled up, were made at the Allen prospect.

The country rock is diorite and hornblende schist of the Roan gneiss. The schist strikes northeast and has a high northwest dip. The prospects are in lenticular shaped outcrops of spodumene-bearing pegmatite which forms a small oval knoll. These pegmatite outcrops are 10 to 20 feet wide and 50 feet or more long. Some of them are in line with one another, and others overlap at the ends. In texture the pegmatite is about medium-grained, the feldspar crystals ranging from less than 1 inch to 4 inches in thickness and the spodumene crystals being 1 to 2 inches long. The spodumene is mostly opaque and gray, but a few crystals with transparent yellowish-green portions were observed. The mica of the pegmatite is yellowish green and occurs chiefly in small crystals half an inch or less in diameter. The cassiterite is present in rather small grains and crystals scattered through parts of the pegmatite. Pieces of medium grade ore, 10 to 12 inches across, were left on the dumps. Cassiterite was not found in all the outcrops of spodumene pegmatite.

Four ledges of decomposed spodumene pegmatite are exposed in a space of 100 feet along the road and about 100 yards east of the tin bearing lead, but no cassiterite was seen in them.

Production

There has been little tin ore produced in North Carolina during the period covered by this report. In 1916 there was a little activity in the tin belt, but none was shipped. In 1917 some mill run tests were made on the property of the United States Tin Company near Lincolnton. This was not, however, put on the market.

MANGANESE

The declaration of a blockade of England and the coasts of her allies, by Germany in February, 1916, and a subsequent destruction of merchant ships have made hazardous the importation of the customary quantities of ferromanganese from England, and have increased the cost of obtaining ores from Brazil and India. Consequently, there has been an energetic search for nearby sources of ore.

While manganese has been found more or less sparingly in a great many areas throughout North Carolina, there are only a few where it gives any promise of occurring in commercial quantity. Up to 1917 there has not been more than a few car loads of mineral containing this metal shipped from North Carolina; and these were largely for experimental purposes. Since the outbreak of the European war, however, there has been an increased interest aroused in North Carolina ores, and some investigation has been made in regard to sources of supply in this State. The principal occurrences of manganese are:

In Cherokee County, about 2½ miles above the mouth of Low Creek, where a very pure manganese ore (pyrolusite) was found. This ore assayed 58.36 per cent manganese.

In Madison County, on the east side of Shut-In Creek, about 2 miles above its mouth, a 4-foot seam of manganese ore is reported to have been found on the land of J. J. Fitzgerald. The ore is psilomelane and of good quality. Nothing is known regarding the extent of the deposit.

In Catawba, Lincoln and Gaston counties there is a belt of manganese slates extending from near Anderson's Mountain in Catawba County to the South Carolina line. While these slates average comparatively low in manganese, portions of them carry a considerably larger percentage of this metal, and may upon investigation be shown to carry a sufficient percentage to make them commercial deposits.

Associated with the magnetites of Ashe County, are ores containing a high percentage of manganese. The most promising deposit is the Piney Creek mine, which is one of the Ballou properties.

In Surry County manganese ore of very good quality has been found in some quantity on the farm of R. E. Freeman, near Dobson.

In Transylvania County, about 7 miles northeast of Brevard, there is a deposit of manganese ore associated with limonite, this latter carrying a trace to several per cent of manganese. Assays of this ore have shown it to contain from 22 to 57 per cent manganese.

Another deposit, located in Beaverdam township, Haywood County, 2 miles southwest of Canton, contains manganese ore of some promise.

In the summer of 1917, Mr. Clarence S. Ross, Geologist of the United States Geological Survey, made an investigation of certain of

the manganese deposits of North Carolina for the State Survey, and below are given the results of this investigation.

"*Clay County:* A manganese prospect is located 8 miles east of Hayesville, Clay County, on the property of Savage Brothers and the Hiawassee Lumber Company. Both pieces of property are controlled by Savage Brothers, of Murphy. It is 27 miles to Murphy, but a railroad has been graded to Hayesville, 8 miles away. The property itself is several miles from any road whatever at present. The elevation is between 2,500 and 3,000 feet. Good timber covers all the region. There is a belt of manganiferous slates extending from a cove near the headwaters of Mill Branch Creek on the south side of the Vineyard Mountain southwest almost to Shooting Creek, a distance of about two miles. The strike is S. 30° W., and the dip about 45° East. The width varies from 300 feet up to nearly one-fourth mile. The property has been prospected by Savage Brothers by 15 cross trenches. No depth over ten feet has been reached. The surface has been rather completely prospected, but nothing is known about the deposit in depth. Near the north end there are seams of manganese ore in the slates, but they do not occur in amounts to constitute a source of ore. Near the south end there is much float of hard black siliceous manganese bearing slate, or manganiferous sandstone. This is the so-called hard ore, but it is too low grade to constitute ore. It does not seem advisable for Savage Brothers to continue work on this prospect, as it offers very little encouragement. The slates in this region are very similar to those of the belt in the central part of the State running through Gaston, Lincoln and Catawba counties. It is not as rich in manganese as the deposits near Kings Mountain, which have not been a paying proposition to date.

"*Cleveland County*: The manganese deposit near the base of Kings Mountain was examined. Here the belt of manganiferous slates is about 1,000 feet wide. Nearly a thousand feet of trenches and other pits have been made. The deposit at this locality is now well exposed to a depth of 20 feet. A car load of the ore has been shipped for experimental purposes. The slates exposed in the trenches vary from a light gray micaeous slaty schist to a nearly black slate quite high in manganese. None of the slates are manganese ore, however. The best ore is derived from seams and stringers that cut the slates in all directions; but which most often follow the schistosity roughly. These vary from a few inches to a few feet in width. Usually they are only a few inches wide, and none were exposed more than a foot wide. The ore shipped consisted of slaty material that had been enriched, probably by leaching of the siliceous material, and possibly by redeposition of manganese oxide in the place of this material. Some of the best ore is a very pure pyrolusite in the form of nodules and botryoidal masses, but this portion of the material shipped was small. Some is composed of alternating bands of manganese oxides and quartz. Even though the material shipped is high grade enough to be an ore of manganese, it would constitute only a small percentage of the material removed. The stringers that can be considered ore are all small and nonpersistent.

"*Surry County:* A manganese deposit belonging to Mr. R. E. Freeman is situated 12 miles west of Mount Airy, Surry County. Active prospecting is being carried on by a competent man. Several trenches have been cut

4 to 8 feet deep and a pit has been sunk 12 feet. The deposit as developed is 50 feet wide and 150 feet long. One wall is mica schist and the other quartzite with a little fine grained soft manganiferous slate between. The deposit is almost entirely composed, however, of pyrolusite cut by bands and stringers of quartz. Some of the quartz is in the form of dark brown cherty material, but most of it is crystalline quartz. There are many masses of splendid ore, and masses of good ore weighing 100 pounds are on the dump. Because of the amount of quartz and the way in which branching stringers of quartz cut good ore, it will require very careful hand cobbing to produce a marketable product. As at present exposed, not more than 25 per cent of the material taken out can be put in shape to ship. High grade material can be produced, however. It is only a question whether the body is large enough and the ore can be hand cobbed closely enough to make it pay. It is to be hoped that further development will disclose ore freer from silica. Workings are so shallow that nothing can be stated about the conditions in depth. It seems to be Mr. Freeman's intention to continue work and make a trial shipment. The ore at this place is very much the best that I have seen so far in my work. It is far better than that that was shipped from Kings Mountain, I should judge. About 150 yards northeast of the point where this work has been done there is another outcrop which has not been investigated, but which indicates that there is a true lead running parallel to the structure of the country rocks. It is stated that there is a belt running northeast for a number of miles along which there are indications of manganese, but no prospecting has been done, and nothing can be learned as to the nature of the belt without some work."

Production

There was a small production of manganese in 1917, but as this was made by one producer the figures could not be given and are included under "Miscellaneous" in the general mineral table, page 10.

PYRITE

Pyrite is another mineral which has come into tremendous importance because of the war. There has been a great deal of search for properties which would produce pyrite in sufficient quantity to warrant opening them up. The Oliver pyrite mine, located about 6 miles from Dallas, Gaston County, is the principal mine in North Carolina. The pyrite occurs in seams and lenses which have been continuous along the strike and in depth, but with varied thicknesses. It is reported that the Federal Pyrites Company of Gastonia has been organized to work this property.

Mr. James Frame claims to have a pyrite mine near Otto, Macon County. He states that the property is located within a mile and a half of the railroad; that the ore is similar to the Spanish lump, and is practically free from gangue. The vein is 10 feet wide and has been proven for a distance of one-half mile.

Production

There was no production of pyrite in North Carolina during the period covered by this report.

CHROMITE

Chromite is one of the minerals the production of which has been affected by the present war. This has caused renewed interest in the deposits of this mineral in this country and is directing attention to the North Carolina deposits. The occurrence of chromite is in the peridotites and allied igneous basic magnesian rocks, or in serpentines that have resulted from the alteration of these.

The mining of chromite in this country has always been attended with considerable uncertainty on account of the pockety nature of the deposits; for chromite is not found in veins but in pockets or bunches of varying dimensions, which may or may not be connected with one another and are limited in extent; so that with the exhaustion of a particular pocket of chromite there will often be more or less dead work to be done before another is encountered. Usually no estimate can be made regarding the amount of chromite on a property beyond that which is exposed by the actual work done. The fact that ten tons or ten thousand tons have been taken out of one pocket does not signify that it is still a good deposit, but if a certain pocket has been productive of a large yield this would serve as a strong indication of the existence of other pockets near by. Yet if a deposit of this mineral is found near the contact of peridotite and other country rock, and if this peridotite formation is very extensive and the chromite is found in considerable quantity, there is a probability that large deposits will be found in the area.

While chromite is found almost universally associated with the peridotites of North Carolina, it is only in a few localities that it occurs in quantity. One of the most promising deposits in the State is in Yancey County at Mine Hill on Mine Fork of Jack's Creek, alongside of the Bakersville road, five miles north of Burnsville, county seat. The ore occurs in a large peridotite formation which outcrops on both sides of the road. What little work has been done on this deposit gives indication that chromite occurs in quantity. The C. C. & O. Railroad from Erwin, Tennessee to Green River Station, North Carolina, runs within three and a half miles of the property. An analysis of a selected sample of this chromite showed 58 per cent of chromic oxide, but judging from the character of the ore, a 52 per cent ore can probably be readily obtained by hand picking and cobbing. The property is owned by J. Bis Ray of Burnsville.

Associated with the large peridotite area or formation in the vicinity of Webster, Jackson County, chromite has been found quite abundantly at a number of points near the contact of the peridotite with the country rock. The principal work has been done on the lands of David Schneider, Joseph Hooker, Lawrence Buress, Alf. Wilson, James Ashe and Daniel Fulbright, all of Webster, North Carolina. The work done shows the presence of a considerable amount of chromite, but it is not sufficient to demonstrate whether it is to be found in sufficient quantity to make profitable mining. These chromite deposits would be from three to five miles from the railroad.

Another property that is being devoloped is on Big Ivey Creek in Buncombe County, about 16 miles northwest of Asheville, and 9 miles from the railroad. There is considerable chrome sand on the property, which is readily concentrated, and, as reported, the concentrates contain 54.09 per cent of chromic oxide. The rock ore, which had been hand-cobbed, gave on analysis 48.78 per cent of chromic oxide. This property is being developed by Mr. F. L. Plaisance of Asheville.

A promising deposit of chromite occurs in the Balsam Gap peridotite area and is located on both sides of Dark Ridge Creek about 175 yards to the south of the Dark Ridge trestle of the Murphy branch of the Southern Railroad. A number of open cuts and pits have been made which show the presence of chromite in some quantity. There is a large quantity of float ore in the vicinity which, with a nearness to the contact of the peridotite and gneiss and the pockets and veins already uncovered, point to this locality as a promising one for further development; and its nearness to the railroad is also greatly in its favor.

All North Carolina ores are high grade, but the existence of large deposits have not as yet been conclusively shown; but the four localities mentioned above are worthy of further investigation.

Production

There was a production of chrome ore in North Carolina during 1917 made by the Carolina Chrome Company at Webster, Jackson County. This was shipped to Philadelphia.

ABRASIVE MATERIALS

Among the list of materials used for abrasives, North Carolina can furnish Corundum and Emery, Garnet, and Millstones. Of these natural abrasives, North Carolina is better supplied with corundum than

any of the other States, there being over 60 corundum localities known in the State, which extend over a considerable area. At the present time, however, it is known to occur in commercial quantity in only four counties: Clay, Macon, Jackson and Transylvania. These corundum deposits should be of great economic importance to the State. The principal mines are the Corundum Hill at Cullasaja, and the Mincey at Ellijay, Macon County; the Buck Creek or Cullakeenee, Clay County; the Socrates, Bad Creek, and White Water near Sapphire, Jackson County; and the Burnt Rock, and Brockton in Transylvania County. The corundum at all these localities is associated with peridotites. At the Scaly Mountain deposit in Clay County the corundum is associated with quartz schist; and at the Caney Creek mine in Jackson County it occurs in chlorite schist. Besides these, there are a number of other deposits that have been developed, and others that are promising prospects, such as the property of the North Carolina Corundum Company at Little Buck Creek, Macon County; a deposit in Woodfin Cove, Balsam Mountain, near Hall, Jackson County; the Corbin and Grimshaw property near Montvale, Transylvania County; and the Carter mine in Madison County, near Democrat, Buncombe County.

The corundum and emery deposits are described in detail in Volume I of the publications of the North Carolina Geological and Economic Survey.

Garnet is another abrasive material that is mined to some extent in North Carolina. There are many localities in the State where garnet occurs in commercial quantity, but most of these are nonproductive on account of their distance from railroad transportation. The only deposit which is producing at the present time is the deposit near Shooting Creek, Clay County, owned by N. N. Rogers. The rock is crushed and concentrated on Bartlett concentrating tables.

The millstones or buhrstones produced in North Carolina are made mostly of garnet which is quarried and made into millstones. This is obtained from near Faith and Salisbury, Rowan County. The millstones are used mostly for grinding corn and oats. At Parkewood, Moore County, a quartz conglomerate was quarried in 1914 and made into millstones. These stones were known as the North Carolina grit.

Production

In 1913 the only abrasives produced were garnet and millstones. The Blue Ridge Garnet Company produced garnet at Shooting Creek,

Clay County. It is reported that all of the 1913 product was shipped abroad. Three operators reported productions of millstones in 1913, all of these being from near Salisbury, Rowan County.

In 1914 three operators reported productions of millstones, two from Rowan County, and one from Moore County.

In 1915 two operators reported productions of millstones from Rowan County, this being the only abrasive produced in that year.

In 1916 there were two operators who reported a production of millstones in Rowan County and one production of garnet was reported from near Willetts, Jackson County, by the Great Ruby Mining Company.

In 1917 North Carolina again comes into prominence as an abrasive producing state. There were three mines which produced corundum and emery, two in Macon and one in Jackson County, the combined output being 820 short tons, valued at $67,461. There was a production of garnet from Shooting Creek, Clay County, during this year and one operator from Rowan County reported a production of millstones.

In the table below there is given the total value of the production of abrasives from 1901 to 1917, inclusive:

PRODUCTION OF ABRASIVE MATERIALS, 1901—1917, INCLUSIVE.

Year	Corundum		Garnet		Millstones		Total Value
	Quantity	Value	Quantity	Value	Quantity	Value	
	Tons		*Tons.*		*Pairs.*		
1901	325	$ 48,840	775	$ 43,000		$	$ 91,840
1902			260	10,040	50	1,425	11,465
1903			*403	12,250	63	902	13,152
1904			*202	6,586	208	6,500	13,086
1905	†1,150	9,000			196	2,652	11,652
1906					205	4,100	4,100
1907							‡15,469
1908						4,052	4,052
1909						9,188	9,188
1910						7,981	7,981
1911							§9,773
1912							*a*10,914
1913						8,772	8,772
1914						5,164	5,164
1915						12,002	12,002
1916				6,600		7,889	14,489
1917	820	67,461				2,875	*b*70,336

*Including production of corundum. †Including production of garnet.
‡Including corundum, garnet, and millstones. §Including garnet and millstones.
*a*Including garnet, millstones, and small quantity of feldspar, said to have been used for abrasive purposes. *b*One producer.

Producers of Abrasives

Corundum and Emery

Frank Grant, Westfield, Mass. Mines, Macon County, North Carolina.

Hampden Corundum Wheel Co., care W. P. Leshure; Corundum Hill Mine, Cullasaja, Macon County, N. C., and Springfield, Mass.

Great Ruby Mining Co., care Silas A. Jones; Willets, Jackson County, N. C.

Garnet

Blue Ridge Garnet Co., care N. N. Rogers & Son, Shooting Creek, Clay County, N. C.

Millstones

B. E. Eagle, Salisbury, N. C., R. No. 3.

Fisher & McCombs, Salisbury, N. C., R. No. 3.

J. T. Wyatt, Salisbury, N. C., R. No. 3.

MICA

For many years North Carolina has led in the production of mica in the United States. The industry commenced about 1867 or 1868, and in a few years was in a flourishing condition. Mica mining began in the mountain counties and has persisted there to the present. Good mines have been worked intermittently in several counties of the Piedmont plateau, but the bulk of the production has come from the northwestern side of the Blue Ridge. In the Mountain region, mica deposits have been worked in nearly every county from Macon and Jackson on the southwest to Ashe County on the northeast. Mitchell and Yancey Counties have probably been the largest producers, but Macon, Jackson, Haywood and Ashe counties have also been important. In the Piedmont region large productions of mica have come from Cleveland, Gaston, Lincoln and Stokes counties.

A feature of mica mining in North Carolina is that much of the output is furnished by small mines or prospects worked intermittently by farmers at times when crops do not require their attention. A number of large mines are also operated more or less regularly and yield much fine mica. Smaller quantities of mica are obtained more or less as a by-product during the mining of kaolin and feldspar. A part of the output of sheet mica of small ores is obtained from the dumps of old mines, but most of the dumps have now been pretty thoroughly worked over.

The greater part of the mica is handled by several large companies, most of whom purchase from the small mines, although some companies both operate their own mines and also purchase from others. Generally, the mica is brought to an advanced stage of preparation for the market before being shipped from the State. Part is split, closely trimmed, graded as to quality and size, and is then shipped for final

manufacture; part is trimmed or manufactured into patterns ready for use in the different trades. Only a small part of the sheet mica mined is shipped without being either manufactured or carefully graded. The bulk of the scrap mica is ground in the State. Small trimming plants for the first sorting of the roughly mined mica are scattered over the mica region and at many of the mines. Well equipped trimming plants are located at Asheville, Plumtree, Spruce Pine, and Penland. Mica grinding mills are located at Asheville, Plumtree, Spruce Pine, and Micaville.

Uses*

"The different uses to which mica is put depend on its form—whether in sheets or in powder. Sheet mica is used in the electrical industry, for glazing, and to some extent for other purposes. Ground mica is used chiefly in the decorative trades and in insulation.

"Sheet mica finds its greatest use in the electrical industry, where an insulating, noninflammable material is necessary. It is used in sheets and as washers and disks in dynamo electric machinery, electric light sockets, spark plugs, insulators, guards in rheostats, fuse boxes, and telephones. Flexible cloth and tape, covered with mica, find varied uses in electrical apparatus. Sheet mica is used for glazing the fronts of stoves and for making lamp chimneys and lamp shades. It is also used in spectacles, automobile shields, phonograph diaphragms, in windows where glass would be broken, and in lantern transparencies.

"Ground mica is used for decoration in wall paper, to which it gives luster and brightness; in fancy paints, ornamental tiles, concrete, rubber goods, pipe and boiler coverings, insulating compounds, fireproof paints and coverings, patent roofing material, molded mica (ground mica mixed with shellac), and calico printing; as absorbent for nitroglycerin in the manufacture of "mica powder," in tempering steel; to a large extent as a lubricant for wooden bearings, or, mixed with oil, as a lubricant for metal bearings; and as a filler for various products. Tar and other roofing papers are coated with coarsely ground mica to prevent sticking when they are rolled for shipment. A possible value of ground mica as a chemical source of potash salts is indicated in a recent Geological Survey report.[1]

"It is understood that sheet mica has come to be of importance as a war mineral through its use abroad as windows in masks worn for defense against asphyxiating gases, and for other uses where a transparent, noninflammable, nonshattering material is necessary, as in automobile goggles and in windows for armored cars.

"Several trade names have been given to the mica products described below.

"Micanite is a term applied to a mica board made from many small, thin sheets of mica, which are fitted together and built up by successive layers that are cemented with shellac and then subjected to pressure under heat to dry out the shellac. Large sheets thus made are suitable for many electrical purposes.

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*Mica in 1916, by Waldemar Schaller, Min. Res. U. S. G. S. 1916. Part II, pp. 291-308.

[1]Butler, B. S., Potash in certain copper and gold ores, with a note on muscovite, by George Steiger: U. S. Geol. Survey Bull. 620, pp. 227-235, 1916.

"Silberglimmer (silvery mica) is muscovite which has been heated to a sufficiently high temperature to make it softer and opaque and silvery in appearance. It is also known as annealed mica and finds a use in certain parts of electric apparatus.

"Micarta is an artificial mica product developed by the Westinghouse Electric & Manufacturing Co., of Pittsburgh, Pa., and is intended to take the place of hard fiber, glass, porcelain, hard rubber, builtup mica board, rawhide, molded compounds for use in commutators, bushings, brushholder insulation, noiseless gear blanks, conduits for wiring spools for spark coil and magnet windings, wireless coil separators, and water-meter disks. Micarta is a tan colored, hard, homogeneous material that can be sawed, milled, turned, and threaded. Thin sheets can be punched, and it is claimed that it will not warp, expand, or shrink beyond very small limits. Two grades of micarta are made. One, known as bakelite micarta, is infusible and will resist heat to a point at which carbonization of some of the ingredients takes place. It is insoluble in nearly all ordinary solvents, such as alcohol, benzine, turpentine, and weak acid and alkali solutions.

"Micamima, prepared by the Crawford Mica Co., of Crawford, Neb., is a coarsely ground mica used in the manufacture of concrete facing material; mixed with other minerals it is used to give the effect of natural rock, and it may be used for different decorative purposes.

"Micolith, prepared by the Texas Mica Co., of Pecos, Tex., is another similar product used to give the effect of natural rock to concrete facings.

"Tungash, as the Denver Mining & Manufacturing Co., of Denver, Colo., calls its product, is a bronze-colored, metallic looking material of value for decoration. The crude biotite mica, altered and hydrated, has a dull greenish-black appearance when mined. On being heated it expands to a light product, which has a rich golden bronze color and a decidedly metallic luster.

"Clinomica is the name given by the American Mica Co., 52 Broadway, New York, to its ground clinochlore, a mineral of the chlorite group. Clinomica possesses essentially the qualities of ground mica, and is used as a dusting material in the rubber and composition roofing industries, for paints, cements, lubricants, molded electric insulation, and as a filler for various products.

"Rimco is mica ground by a nonmetallic process by the Richmond Mica Co., Richmond, Va., for use as a tire powder. It is also used by manufacturers of oils and lubricating greases."

Localities

Mr. John E. Smith, in the summer of 1917, visited several mica localities and made the following notes:

Cleveland County: Wm. H. Blanton, Lattimore, dealer and producer. Mr. Blanton gives his entire time to the mica business and buys nearly half of the material marketed. From August, 1916, to February 1, 1917, he sold block mica only. Since the latter date he has been buying and producing sheet mica, punch mica, scrap mica, etc. In July, 1916, he leased 2 acres of land located six miles southeast of Lattimore, that had been bought by J. E. Burleson and operated continuously until August, 1917. The mica

is taken from a pegmatite dike and the mica removed from an open cut along the dike. The cut is about 200 feet long, 47 feet deep, 4 to 10 feet wide, averaging about 6. When seen, the water level in the cut was about 20 feet below the surface. Nearly $10,000 worth of mica was taken from this cut.

Method of working: Blasting, using dynamite sticks, sledge, crowbar, pick, etc., in the deeper parts. Hoisted by hand windlass, pump, double stroke hand.

Sizes	Production	Price Per Pound
1½ x 2 in.	200 lbs. per mo.	$0.40 to $1.00
2 x 2 in.	100 lbs. per mo.	.65 to 1.25
3 x 2 in.	150 lbs. per mo.	1.00 to 1.65
3 x 3 in.	50 to 75 lbs. per mo.	1.45 to 1.90
3 x 4 in.	40 lbs. per mo.	1.75 to 2.40
3 x 5 in.		2.15 to 3.00
4 x 6 in.		2.75 to 3.00
6 x 6 in.		3.00 to 4.00

Other sizes produced are 6x8, 8x10, 12x12, 12x14, and 12x16. Punch mica produced, about one ton per month, sold at 5c to 10c per pound. The best production occurred in March and April with second best in July and August.

Cleveland County, Lattimore. Five and a half miles southeast of Lattimore, on land owned by C. J. Hamrick, and rented from him by W. H. Skinner and Bud Weathers, a mica mine is being worked by the renters. The mica occurs in a pegmatite dike 2 to 4 feet wide, and was opened in July, 1917. At present, it has been worked to a depth of 11 feet along a distance of about 20 feet, and is yielding good mica (muscovite). This dike is very nearly vertical. On the land of Mr. Green, nearby, some mica has been taken, in which the veins dipped at a steep angle and consequently were not worked very deeply or thoroughly.

Blanton and Harrel began business about June 1, 1917, and are mining as well as buying.

At the Isinglass Mill Mica Mine, 3 miles north of Rutherfordton, N. C., an attempt was made 2 or 3 years ago to obtain mica by working over the dump and saving the material wasted in it. In this, 2 shaft screens were employed. They were cylindrical, made of poultry netting having about 1½ inch meshes, the poultry netting being doubled to form the cylinder. Only a small portion of the dump was worked when the operation was discontinued. This attempt was evidently unsatisfactory, as the work has not been taken up again since.

Jackson County, near the railroad, between Beta and Addie, an attempt to obtain mica by rescreening the dump from an old mica mine was made. The screen was about 3 feet by 5 in size, placed on an incline and used in the same way in which sand is screened for mortar. This was evidently a failure, as but little material was reworked.

Macon County: Polly Roby mica mine, near Iola; G. W. Grindstaff, superintendent. Shaft 50 feet deep, 7 feet in the clear, walled with hewed timbers. Tunnels also carefully timbered. Vein 18 to 24 inches wide on each side of a wide quartz center. This vein or dike is irregular in direction and extent. The company is sinking a new shaft about 20 feet from the bottom of the 50-foot shaft; that is, below the 50-foot level. The tunnels are 6 feet high. Much water is encountered, running about 60 gallons per minute. This requires pumps to be kept in operation day and night; consequently the company employs sufficient men to operate day and night shifts.

The equipment consists of 3 boilers, 35, 6 and 10-horsepower; 20-horsepower hoist; 3 pumps, Fairbanks, Worthington (capacity 100 gallons per minute), Morse (capacity 500 gallons per minute); repair shop; tool houses, etc. Wood is used as fuel at present, as the cost of coal would be $7.75 per ton. 23 men are employed and the product is about 2,000 lbs. per week, all grades. It costs the company 40c a ton to have this mica hauled to Sylva, Jackson County.

This company is also operating the Buoy Mine, not far from Herman Dean's store, on the road between Franklin and Eulalie.

Production

There is given in the following table the approximate value and distribution by counties of the production of mica for the years 1911 to 1917, inclusive:

PRODUCTION OF MICA IN NORTH CAROLINA 1911—1917, INCLUSIVE, BY COUNTIES.

County	1911	1912	1913	1914	1915	1916	1917
Ashe	$ 4,000	$ 5,300	$ 3,500	$ 1,500	$ 2,500	$ 2,380	$ 8,700
Avery	----------	----------	26,659	24,770	68,111	83,200	77,050
Buncombe	255	531	520	340	----------	800	1,200
Cleveland	1,000	2,300	3,100	2,700	3,500	500	1,034
Franklin	----------	----------	----------	----------	----------	200	1,100
Haywood	4,000	5,732	6,241	4,780	9,000	38,000	29,840
Jackson	10,875	25,743	51,366	45,000	40,634	22,300	59,900
McDowell	400	540	540	420	500	900	1,500
Macon	54,800	53,823	50,322	36,000	238	67,800	60,162
Madison	870	1,400	1,200	500	500	400	2,000
Mitchell	134,745	147,430	108,430	69,420	109,202	75,000	126,080
Rutherford	----------	----------	----------	----------	----------	500	3,100
Stokes	130	200	535	240	500	----------	--------
Swain	----------	----------	----------	----------	----------	2,500	10,50
Transylvania	1,800	2,800	2,300	1,100	1,060	2,300	3,100
Watauga	----------	100	700	500	500	800	2,200
Yancey	4,200	10,650	12,500	8,000	64,348	125,000	189,869
Totals	$217,075	$256,549	$267,913	$195,270	$300,593	$422,580	$ 577,341

The next table gives the value of the total production of mica, including both sheet and scrap, for the years 1900 to 1917, inclusive:

PRODUCTION OF MICA IN NORTH CAROLINA, 1900—1917.

Year	Sheet Value	Scrap Value	Total Value
1900	$ 65,200	$ 36,262	$ 101,462
1901	79,849	14,200	94,049
1902	81,653	2,219	83,872
1903	86,300	2,400	88,700
1904	100,724	3,410	104,134
1905	100,900	3,375	104,275
1906	205,756	11,940	217,696
1907	209,956	15,250	225,206
1908	114,540	13,330	127,870
1909	122,246	26,178	148,424
1910	193,223	37,237	230,460
1911	187,496	29,579	217,075
1912	219,874	36,675	256,549
1913	230,674	37,239	267,913
1914	171,370	23,900	195,270
1915	266,650	33,943	300,593
1916	380,700	41,880	422,580
1917	543,207	34,134	577,341

For many years North Carolina has been the largest producer of mica in the United States. In order to show the ratio of the production of mica in this State to the total in the United States, and the comparison of these figures with the value of the imports of mica, there is given in the table below figures covering these points for the years 1903 to 1917, inclusive:

PRODUCTION OF MICA IN THE UNITED STATES AND IN NORTH CAROLINA AND THAT IMPORTED INTO THE UNITED STATES FROM 1903 TO 1917.

Year	Production in N. C., Value	Production in U. S., Value	Import Value
1903	$ 88,700	$ 143,128	$ 317,969
1904	104,134	120,316	263,714
1905	104,275	178,588	403,756
1906	217,696	274,990	1,042,608
1907	225,206	392,111	952,259
1908	127,870	267,925	266,058
1909	148,424	280,529	618,813
1910	230,460	337,097	725,823
1911	217,075	355,804	502,552
1912	256,549	331,896	755,584
1913	267,913	436,060	943,783
1914	195,270	329,956	629,484
1915	300,593	428,769	692,269
1916	422,580	594,391	1,071,356
1917	577,341	757,346	1,430,048

Producers, Buyers and Owners of Mica Properties

A great deal of mica is mined in a small way by farmers in the mountain coves and sold to stores or companies or agents who buy for companies located within or outside of the State. Many of the companies located within the State mine a good deal of mica and also buy from these smaller producers. The following is a list of those who reported a production in 1917:

Asheville Mica Co.	Biltmore, N. C.
J. W. Autrey, (Mitchell and Yancey Counties)	Harvard, N. C.
W. W. Avery	Plumtree, Avery County, N. C.
R. S. Ballew & Co.	Celo, Yancey County, N. C.
J. A. Bartlett	Spruce Pine, Mitchell County, N. C.
Frank Bennett	Celo, Yancey County, N. C.
M. D. Billings	Franklin, Macon County, N. C.
A. W. Bitner	Burnsville, Yancey County, N. C.
Edward Blake	Newdale, Yancey County, N. C.
J. Boyd Bland	Plumtree, Yancey County, N. C.
John A. Bowditch	Busick, Yancey County, N. C.
W. N. Bryson	Cullasaja, Macon County, N. C.
Mark W. Bryson	Gay, Jackson County, N. C.
A. Buchanan	Spruce Pine, Mitchell County, N. C.
H. R. Buchanan	Plumtree, Avery County, N. C.
Moses L. Buchanan	Spruce Pine, Mitchell County, N. C.
J. E. Burleson Mica Co.	Spruce Pine, Mitchell County, N. C.
Carolina Mineral Co.	Penland, Mitchell County, N. C.
H. F. Carpenter	Spruce Pine, Mitchell County, N. C.
Clinchfield Products Corporation	120 Broadway, New York Mines in Mitchell County, N. C.
J. L. Cook	Spear, Avery County, N. C.
C. C. Cunningham	Franklin, Macon County, N. C.
Elk Mining Co.	Plumtree, Avery County, N. C.
J. B. Ewing	Boonford, Mitchell County, N. C.
W. T. Fonts and J. A. Ray	Franklin, Macon County, N. C.
Intermont China Clay Co.	Bandana, Mitchell County, N. C.
Dr. Chas. H. Gifford	97 Central Park, West, New York, N. Y.
H. D. Grindstaff	Toecane, Mitchell County, N. C.
E. C. Guy	Newland, Avery County, N. C.
J. L. Hall	Newdale, Yancey County, N. C.
F. O. Havener	Franklin, Macon County, N. C.
Haywood Lumber and Mining Co.	Waynesville, Haywood County, N. C.
D. N. Howell	Boonford, Mitchell County, N. C.
J. E. Howell	Bakersville, Mitchell County, N. C.
J. T. Moore	Franklin, Macon County, N. C.
Mountain State Mica & Mining Co.	Ardmore, Pa., Mines in Mitchell County, N. C.

Geo. W. Owens	Greenmountain, Mitchell County, N. C.
E. H. Patrick	Plumtree, Avery County, N. C.
E. Peltz Mica & Milling Works	Newdale, Yancey County, N. C.
J. R. Penland	Vixen and Burnsville, Yancey County, N. C.
M. H. Putman	Bandana, Mitchell County, N. C.
John E. Rickman	Iotla, Franklin County, N. C.
William Robison	Micaville, Yancey County, N. C.
E. M. Robinson	Bandana, Mitchell County, N. C.
N. N. Silver	Micaville, Yancey County, N. C.
R. W. Sparks	Boonford, Mitchell County, N. C.
Robert A. McDonald	Sylva, Jackson County, N. C.
Lea Whetstine, Son & Co.	Celo, Yancey County, N. C.
General Watkins	Cullasaja, Macon County, N. C.
Lee F. Wild	Sylva, Jackson County, N. C.
Wilson and McNeill	Burnsville, Yancey County, N. C.
W. W. Wiseman	Bakersville, Mitchell County, N. C.

QUARTZ

Quartz, an oxide silicon, or, as it is sometimes commercially called, silica, or silix, is one of the commonest minerals and is very widely distributed in nature, being a constituent of many of the crystalline rocks and the main constituent of all sandstones. It is also found in quantity at widely varying localities, notably as a constituent of pegmatitic dikes. The uses of this mineral are quite varied, it being used in the manufacture of paste for wood finishing; in the manufacture of pottery and tile; sandpaper, and certain scouring soaps and powders; in the manufacture of a wood filler; glass; and in certain instances it is mined for a flux in copper smelting. When it is colorless and perfectly transparent, it is of considerable value for cutting into spheres, cubes, and other forms for ornamental purposes. There are also many varieties of quartz which are of value as gems.

There are large deposits of quartz in western North Carolina, many of which are associated with mica, and some of which should be available for many of the purposes enumerated above. As a by-product in mica mining, its cost of production would simply be for grinding, and with favorable transportation rates, it should be able to compete with quartz produced in other localities.

Two miles south of Murphy, Cherokee County, on the farm of J. T. Tait, a vein of quartz is being worked. This vein is reported to be 80 feet high, 25 feet wide, 18 feet of which is quartz. The quartz is shipped to Ducktown, Tenn., and sold as a fluxing material.

The Oliver mine, near Mount Holly, Gaston County, has been operated steadily for the past four years. Owing to the fact that there

have not been over two producers of quartz in any of the years covered by this report, the production is included under "Miscellaneous" in the general mineral table, page 10.

BARYTES

The mineral barytes does not usually occur in well defined veins, except when an accessory mineral in certain metallic veins; but it is more often found in a series of pockets, lenses, or seams of varying dimensions. These are more or less in line, often following the dip of the rock with which they are associated; and this rock is, in many cases, a limestone.

Barytes (barite or barium sulphate) is used chiefly in making mixed paints, in which white, ground, and water float barite, are employed as a pigment. Ground barite is also used in the rubber industry and, to some extent, by the makers of heavy glazed paper and ink. Lithopone, a chemically prepared white pigment, consisting of about 70 per cent barium sulphite and 30 per cent zinc sulphide, is one of the chief constituents of the "flat" wall paints so extensively used in office buildings and hospitals, replacing the less desirable paper and calcimine wall finishes.

Since the beginning of the war, a barium chemical industry has been established in the United States to supply barium carbonate, nitrate, chloride, chlorate, hydrate, and binoxide, which were formerly imported largely from Germany. The barium chemicals have a wide variety of applications, perhaps the most important of which are the use of barium binoxide in the preparation of hydrogen peroxide; that of barium chloride as a water softener, and that of various salts in the manufacture of optical glass.

Most of the operating mines in North Carolina are in the vicinity of Stackhouse, Madison County. It is reported, however, that in 1915 and 1916 there was some development work on the barytes mine near Bessemer City, Gaston County.

On the Kings Mountain ridge, which runs in a southwesterly direction from Bessemer City for several miles, there are a number of openings on lenticular veins of pyrite which are closely associated with sericitic schists. The principal mine is the Lawton, 5 miles south of Bessemer City, at the south end of the ridge. Most of the barite bearing veins are east of the highest part of the ridge and lie parallel to the schistosity of the enclosing rocks. The barite is granular and is associated with quartz, galena, and sphalerite.

The Madison County barite belt is about 5 miles long; it extends from Bluff, on Spring Creek, in a northeast direction through Doe Run

and across French Broad River near Sandy. In this belt which is close to a large thrust fault are enfoldent remnants of Cambrian quartzite (snowbird formation) in the Archean granite, which is the general country rock. The barite occurs in narrow, irregular veins in the granite, particularly near the contact with the quartzite, and to a less extent, in the quartzite. There is said to be very little impurity in the Stackhouse barite. The mine openings are mostly well above the streams, and it would seem that there is a considerable reserve of the mineral in the deposit.

A deposit of barite 6 miles south of Hot Springs, Madison County, on Spring Creek, and known as the Noah Wardrop Barite Mine, was examined in the summer of 1917 by Mr. John E. Smith. The barite is approached through the tunnel about 300 feet long, entering on a level near the foot of the hill. The shaft enters from a point near the top of the hill and follows on the vein, which is on the angle of the dip about 55° northwest. The shaft is now about 150 feet deep and the barite occurs in lenses up to 6 feet in thickness, averaging about 2 feet thick. These lenses lie beneath a roofing of red to brown rotted material, forming an impure clay, and above a flooring of several "sandstones"—a decaying fine grained granite. Above the roof is a green stone, firm and compact, except where barite is being changed to limonite. This is a protection against the heavy weight above. The hoisting is done by steam power. The tunnel cuts the shaft about 40 feet above the present face of the barite, and this affords excellent ventilation in the mine. The barite is sorted by means of a fork, only the larger pieces being used at present. This is hauled to Hot Springs for shipment.

Production

For the past five years the production of barytes has been made by less than three producers, and therefore the statistics are given under "Miscellaneous Minerals," in the total production of the State. The figures used for the barytes are the value of the crude and not of the refined barytes, which is the condition in which most of it is shipped.

Owners of Barytes Properties and Operators During 1917

Charles L. Lawson, Bessemer City, Gaston County, N. C.
J. T. & J. B. Harrison, Bluff, Madison County, N. C.
Thomas Frisbee, Bluff, Madison County, N. C.
Anson G. Betts & Co., Sandy Bottom (Stackhouse) Madison County, N. C.
Carolina Barytes Co., Stackhouse, Madison County, N. C.
Ben W. Gahagan, Stackhouse, Madison County, N. C.
Amos Stackhouse & Sons, Stackhouse, Madison County, N. C.
Thompson, Weinman & Co., Stackhouse, Madison County, N. C.

MONAZITE

"*The mineral monazite contains a variable but small percentage of thoria, which is extracted and sold in the trade as thorium nitrate. Upon ignition this nitrate is changed to the oxide or thoria, which glows intensely when heated and is used in the manufacture of incandescent mantles for gas lights. Monazite occurs throughout the world but forms only a very small fraction of 1 per cent of the rock containing it. On decomposition of this rock the monazite and other resistant minerals are not attacked chemically but remain unaltered and, being much heavier than the products of decomposition, are gradually but slowly concentrated in the residue from the broken down rock. If the ocean encroaches on an area of such decomposed rock, the selective action of the sea waves will still further concentrate the heavier minerals along the beaches. River waters will likewise effect a concentration of the heavy minerals.

"In both North Carolina and South Carolina such river deposits were first worked about 1887 and soon yielded large quantities of monazite sand, the production in 1895 exceeding 1,500,000 pounds. At this time monazite from the rich coastal deposits of Brazil entered the market, and the domestic production fell to almost nothing, that for the two years 1896 and 1897 being worth only $3,480. The price of thorium nitrate, which was about $200 a pound in 1895, when the production in the Carolinas reached its maximum, was rapidly lowered to about $7 a pound in Europe in 1900. During the next few years it rose to about $11 a pound, and the increase in price, together with a world-wide search for additional deposits of monazite sand, served to revive the industry, until in 1905 over 1,000,000 pounds of monazite sand was again produced in the Carolinas. Much of this output was exported to Germany. In 1906 and again in 1910 the price of thorium nitrate was considerably reduced, and in 1913 it was selling in this country at $2.60 a pound. At this low price it became unprofitable to mine monazite sand wherever the cost of mining was high. After 1905 the domestic production gradually decreased, and since 1911 it has been inappreciable.

"In 1909 monazite sand was discovered in Travancore, India, and soon large amounts were produced. The Carolina sand has had to compete with these deposits and others in Brazil, which could be mined very cheaply. Most of the Brazilian sand and all of the India sand was exported to Germany until the beginning of the European war.

*"Mica, Monazite, and Lithium Minerals," by Waldemar T. Schaller, Bulletin 666-X, U. S. Geological Survey.

Since then most of the sand has been sent to this country, which imported nearly 2,500,000 pounds of monazite sand in 1916. With this increase in imports of monazite sand there has been a steady decline in imports of thorium nitrate, from 119,044 pounds in 1913 to 909 pounds in 1916. In other words, the United States is manufacturing its own thorium nitrate, chiefly from sand imported from Brazil and India. The price of thorium nitrate has gradually increased since the war and now is about $8 a pound, or three times as much as in 1913. This advance in price has again stimulated the domestic production of monazite sand, and small amounts were produced in 1915 and 1916.

"There is still an abundance of monazite sand in the Carolinas, but the Carolina deposits can not be worked extensively in competition with foreign sand. As the United States consumes about one-fourth of the thorium nitrate used in the world, it requires a yearly production of about 2,000,000 pounds of monazite sand (90 per cent monazite containing 5 per cent thoria). Even in its most prosperous times the domestic output did not reach that figure. Whether such a domestic production could be sustained year by year if all imports were cut off cannot be told. The Carolinas, however, could produce enough monazite sand to make this country independent of other sources for several years at least, and if the ashes of broken mantles were conserved by consumers, enough thorium nitrate could be obtained from domestic sources to serve for some time.

"The factors that have prevented a thorough test of the extent of the domestic deposits in recent years are the better quality and cheapness of the imported foreign sands. Both the Brazilian sand and that of India contain a higher natural concentration of monazite and a higher content of thorium oxide than the American sand, the sand from Brazil averaging about 6 per cent thoria and that from India about 9 per cent. The cheapness of labor and transportation in these foreign countries has also deterred domestic exploitation. The market price of thorium nitrate is a good indicator for domestic production of monazite sand, for only at a high price for this manufactured salt can the domestic sands be profitably worked. The importation of large quantities of foreign sand rich in thoria prevents a very high price being paid for thorium nitrate."

Production

There was no production of monazite in North Carolina during 1913 and 1914, but there was a production during 1915, 1916 and 1917, this being obtained principally from Burke, Cleveland, Iredell, Lincoln, and Rutherford counties. There were only two producers in 1915 and two

in 1916. In 1917, however, there were four producers who reported 77,743 pounds valued at $13,806.

In the table below there is given the production and value of monazite mined in North Carolina from 1893 to 1917, inclusive:

PRODUCTION OF MONAZITE IN NORTH CAROLINA, 1893—1917.

Year	Pounds	Value
1893	130,000	$ 7,600
1894	546,855	36,193
1895	1,573,000	137,150
1896	30,000	1,500
1897	44,000	1,980
1898	250,776	13,542
1899	350,000	20,000
1900	908,000	48,805
1901	748,736	59,262
1902	802,000	64,160
1903	773,000	58,694
1904	685,999	79,438
1905	894,368	107,324
1906	697,275	125,510
1907	456,863	54,824
1908	310,196	37,224
1909	391,068	46,928
1910	83,454	10,104
1911		
1912		
1913		
1914		
1915		*
1916		*
1917	77,743	3,806

*Only 2 producers. Included under "Miscellaneous Minerals," table, page 10.

Owners of Monazite Properties in North Carolina and Producers During 1917

Those marked with a star were producers in 1917.

John Alwan*................Cleveland Mills, R. 1, Cleveland County, N. C.
E. C. Bess..................Cherryville, Gaston County, N. C.
Block Gas Mantle Co.........Youngstown, Ohio. Properties in Alexander, Burke, and Cleveland counties, N. C.
J. M. Brittain...............Connelly Springs, R. 1, Burke County, N. C.
Carolinas Monazite Co., care L. A. Gettys..............Shelby, Cleveland County, N. C.
A. F. Cook..................Connelly Springs, Burke County, N. C.
W. A. Cook..................Belmont, R. 1, Cleveland County, N. C.
William Earl Hidden........Ocean Grove, N. J., Tuxedo, Henderson County, N. C.
John R. Hoyle..............Shelby, Cleveland County, N. C.
D. F. Huffman*.............Connelly Springs, Burke County, N. C.

Jacob Johnson..............Cherryville, R.F.D.
Mines in Burke County, N. C.
W. E. Ledford..............Cleveland Mills, R. F. D. 4, Cleveland County, N. C.
Wade McClurd..............Cleveland Mills, R. F. D. 1, Cleveland County, N. C.
J. A. Martin................Ellenboro, Rutherford County, N. C.
M. L. Hannicke..............Bostic, R. 3, Rutherford County, N. C.
New Process Gas Mantle Co...27 and 29 Bank Street, Philadelphia, Pa.
P. L. Newton................Casar, Cleveland County, N. C.
D. F. Parker................Cherryville, R. 1, Lincoln County, N. C.
S. S. Royster Monazite Co.*..Shelby, N. C.
Cleveland and Rutherford counties
A. A. Sain..................Henry, R. 3, Lincoln County, N. C.
James Smart................Ellenboro, Rutherford County, N. C.
James C. Thorpe............Harmony, Iredell County, N. C.
H. H. Van Horn*............Connelly Springs, Burke County, N. C.
O. G. Wilson................Ellenboro, Rutherford County, N. C.
J. A. Newton................Casar, Cleveland County, N. C.

ZIRCON

So far as reported, there has been no production of zircon during the past five years.

In the table below there is given the amount and value of zircon mined in North Carolina from 1902 to 1917, inclusive:

PRODUCTION OF ZIRCON IN NORTH CAROLINA, 1902—1917, INCLUSIVE.

Year	Pounds	Value
1902	2,000	$ 380
1903	3,000	570
1904	1,000	200
1905	8,000	1,600
1906	1,100	248
1907	204	46
1908		
1909	2,000	250
1910		
1911	3,208	802
1912		
1913		
1914		
1915		
1916		
1917		

TALC AND PYROPHYLLITE

North Carolina ranks first among the states in the production of high grade talc, such as is used for pencils, gas tubes, and electrical insulators. There are two minerals which are being mined in North

Carolina and put on the market as talc; one being the pure talc which is a hydrous magnesium silicate, and the other the mineral pyrophyllite, which is a hydrous aluminum silicate. They are very similar in physical properties, but the pure talc is of greater value. The talc deposits are all in the western part of the State, principally in Cherokee, Swain, Graham and Jackson counties; while pyrophyllite is obtained from Moore County and the east central portion of the State.

A deposit in Cherokee County was examined by Mr. John E. Smith in the summer of 1917. The mine is operated by Mauney and Tait of Regal, N. C., and is located a quarter of a mile northeast of Regal, on the east side of the track. This is the old Emerson and Lidle mine and was in operation 16 or 17 years ago. A new shaft was sunk about 30 yards north of the old one. At the time of the examination the shaft was 55 feet deep, 5 feet square in the clear, and walled with hewn timber. The talc "vein" is 9 to 10 feet wide and commercial talc was first found about 15 feet below the surface. It is hoisted from the mine in a 200-pound bucket bound with heavy iron bands, and brought to the surface by means of mule, rope and pulley. The product is yellow talc used for foundry facings and as an oil filler, and sells for $4 per ton, f. o. b. Regal. The talc occurs near the contact between quartzite on the east and vertical mica schist on the northwest, the strike being N. 45° E.

Production

As there is very little talc sold in the crude state, the values given are for the production as it was marketed, and it usually represents the manufactured product.

There is given in the table below the condition in which these products were marketed for the past five years.

Production of Talc and Pyrophyllite in North Carolina During 1913—1917, Inclusive.

	1913		1914		1915		1916		1917	
	Quantity, Short Tons	Value	Quantity, Short Tons	Value	Quantity, Short Tons	Value	Quantity, Short Tons	Value	Quantity, Short Tons	Value
Ground Talc for powders, etc.	4,122	$33,103	845	$ 8,893	1,351	$10,610	1,408	$ 8,953	1,576	$ 15,050
Talc cut into pencils, gas tips, etc.	52	14,393	49	18,499	20	4,750	39	15,750	70	4,000
Talc sold, crude	412	921	300	600	69	2,180	311	9,857	54	216
Soapstone cut into slabs for chimneys, etc.	90	400	4	421	14	3,961	29	7,264	475	22,500
Totals	4,676	48,817	1,198	28,413	1,454	21,501	1,787	41,824	2,175	41,766

The table below shows the quantity and value of talc and pyrophyllite in North Carolina from 1898 to 1917, inclusive:

PRODUCTION OF TALC AND PYROPHYLLITE IN NORTH CAROLINA, 1898—1917, INCLUSIVE.

Year	Quantity	Value
	Short Tons.	
1898	1,695	$ 27,320
1899	1,817	31,880
1900	4,522	75,308
1901	5,819	77,974
1902	5,239	88,962
1903	5,331	76,984
1904	3,801	65,483
1905	4,035	74,940
1906	4,184	66,979
1907	4,085	74,347
1908	3,564	51,443
1909	5,956	77,983
1910	3,887	69,805
1911	3,548	57,101
1912	3,542	63,304
1913	4,676	48,817
1914	1,198	28,413
1915	1,454	21,501
1916	1,787	41,824
1917	2,175	41,766

Producers of Talc and Pyrophyllite During 1917

Alleghany—G. F. Smith, Peden, N. C.
Ashe—Gregory Talc Co., Nashville, Tenn.
Cherokee—Kirkpatrick Development Co., Asheville, N. C.
Madison—Georgia Talc Co., Asheville, N. C.
Moore—Talc Products Co., 11 Pine St., New York.
Swain—N. C. Talc & Mining Co., Hewitts, N. C.

PRECIOUS STONES

There are many of the gem minerals found in North Carolina, and deposits of some have been found in sufficient quantity to become regular producers. There has been but little systematic search for these minerals, but accidental discoveries have been made in various places that have in some cases led to the opening of good deposits of gem material. The principal gem localities are in Macon, Yancey, Mitchell, Lincoln, Alexander, and Cleveland counties. These gems have been described in some detail in Economic Papers Nos. 6, 9, 15, 23 and 34.

The principal gems that have been produced in the past five years in North Carolina have been the amethyst, beryl, quartz, ruby, sap-

phire, emerald, kyanite, and rhodolite. Some of the gems discovered within this period are described as follows:

Amethyst: A few amethystine quartz crystals and one amethyst of good quality was found in 1913 on the R. C. McConnell place, about 3 miles southwest of Mt. Ulla, in Iredell County. The good specimen was found some 20 years ago by the late N. H. Marsh. This was a partly water-worn crystal about 2 inches long and 1¾ inches thick. A large part of it was flawless, with pleasing medium dark purple color. The value of this crystal was not large, but the possibility of a deposit being found is important.

Ruby: Tests were made on the ruby deposits along Caler Fork of Cowee Creek in Macon County during the latter part of 1913. Prospecting was under the charge of N. E. Isbell of Cincinnati, who had charge of the developments at this locality several years before. Mr. Isbell used a churn drill during this work, going to a depth of 65 feet at the "In Situ" Hill locality. Some ruby and sapphire of marketable color were found along with opaque corundum. During the first part of 1914 better equipment in the way of a 3-inch core drill, operated by a 10-horsepower gasoline engine, was installed, and a number of holes will be sunk at the "In Situ" Hill locality to the depth of about 150 feet.

In his report on Gems and Precious Stones for 1914, Mr. Douglas B. Sterrett says:

"Prospecting at the ruby deposits on Caler Fork of Cowee Creek, in Macon County, N. C., during part of 1914 did not result in a definite determination as to whether or not the property can be profitably worked. Earlier work for rubies a number of years ago in the gravel beds in the bottom land along the creek resulted in the discovery of much red and pink translucent corundum and of some clear stones of value as gems. The best stones had a fine ruby color with silkiness and slight cloudiness in some specimens. Prospecting of the gravel beds carried the work back to a point where the valley narrows below a flat. Here ruby corundum was found in matrix and the hillside was called In Situ Hill. At several different times prospecting has been carried on in this hillside in search of the remaining part of the deposit from which the best rubies of the placer ground have been obtained.

"Prospecting work at the In Situ Hill locality was begun in 1913 by the Consolidated Ruby Co., of New York, and was continued in 1914. The new work consisted of a shaft 38 feet deep from the bottom of the open cut at the foot of the hill. From this shaft drifts were run 58 feet west and 80 feet south of east. Several holes were sunk by a churn drill, using chilled steel shot for cutting edges. One of these holes was 103 feet deep, cutting through all the saprolite or decomposed rock into fresh, unaltered gneiss. The fresh rock from the drill core consists both of garnetiferous diorite and garnetiferous biotite gneiss. The garnetiferous diorite would probably yield yellowish brown saprolite just like that found in the upper workings of In

Situ Hill. No pockets containing ruby corundum were found in the drill holes. In the shaft and the underground workings a vein, or seam, was followed, in which several small and one large pocket, or deposit, carrying ruby corundum were found. The largest deposit was a shoot, or chimney, measuring 6½ feet high by 3½ feet wide, and was nearly 4 feet thick. The material taken from this deposit, when washed, yielded about 20 pounds of translucent pink corundum. These crystals range from small size up to a centimeter in diameter and thickness. None of them has fine red color, and most of them are pink to purplish red. Nearly all of the crystals contained small rust cavities up to 2 millimeters in diameter, formed by the decomposition of minute rhodolite garnets similar to those described by Pratt and Lewis.[1]

The corundum crystals are inclosed in whitish kaolin-like deposits, apparently resulting from the decomposition of feldspar or pegmatitic material which originally inclosed the corundum. None of these rubies is of as deep a color or is as clear as those found in the stream gravels below In Situ Hill, but the richness of the pockets adds to the interest of prospecting for stones of better quality."

Beryl: A beautiful beryl, weighing 3 pounds and containing good gem material, was reported by Mr. L. A. Gettys of Shelby, North Carolina, to have been found in Burke County in 1915.

Quartz: Transparent quartz crystals that include goethite needles were mined near Bakersville, North Carolina, by W. G. Bowman in 1915. The hair-like needles of geothite give a rainbow hue to the specimens.

On land of N. C. Pannell, 3½ miles north of Ellenboro, dikes of pegmatite carrying yellow beryl, aquamarine, tourmaline, and irridescent albite feldspar have been located. Mr. Pannell's address is Ellenboro, Route 2.

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[1]Pratt, J. H., and Lewis, V. L., Corundum and the peridotites of western North Carolina: North Carolina Geol. Survey, vol. 1, p. 183, 1905.

Production

There is given in the table below the production of precious stones in North Carolina for the years 1900 to 1917, inclusive:

PRODUCTION OF PRECIOUS STONES IN NORTH CAROLINA, 1900—1917, INCLUSIVE

Year	Value
1900	$ 12,020
1901	24,245
1902	5,300
1903	1,525
1904	10,600
1905	3,350
1906	5,000
1907	7,580
1908	*570
1909	*479
1910	*700
1911	*10,735
1912	*5,655
1913	*849
1914	*3,070
1915	*464
1916	*343
1917	*75

*Estimated by U. S. G. S.

MINERAL WATERS

There is included under the head of "mineral waters" any spring or well water that is sold in bulk or packages for table or medicinal use. Water sold as public supplies is excluded from these statistics, as are also natural waters which have been greatly changed either by the addition of mineral substances or by concentration by evaporation. The figures given below regarding the value of mineral waters are those furnished by the spring owners and represent as nearly as possible the amount received for the water exclusive of prices charged for the containers.

The springs which were in operation during the years covered by this report are as follows:

1913

"The returns from North Carolina show marked increase in the mineral water business during 1913. The sales amounted to 176,068 gallons, valued at $23,877, as compared with 144,708 gallons, valued at $22,385, in 1912, an increase of 22 per cent in quantity and of 7 per cent in value. The average price per gallon decreased from 16 to 14 cents. Parks Spring reported production for the first time. One spring

active in 1912 was idle during 1913, and the output from one spring from which no report was received was estimated on the basis of the production for 1912, these changes increasing the number of commercial springs to 17. Eleven resorts accommodating 1,600 guests were maintained at springs, together with five establishments for bathing in mineral water. A small quantity of water also was used in the manufacture of soft drinks.

"The 16 springs reporting are:

All Healing Spring, Taylorsville, Alexander County.
Barium Rock Spring, Barium Springs, Iredell County.
Buckhorn Lithia Spring, Bullock, Granville County.
Connelly Springs, Connelly Springs, Burke County.
Derita Mineral Spring, Derita, Mecklenburg County.
Haywood White Sulphur Spring, Waynesville, Haywood County.
Huckleberry Spring, Durham, Durham County.
Jackson Springs, Jackson Springs, Moore County.
Midas Spring, near Huntersville, Mecklenburg County.
Moores Springs, Moores Springs, Stokes County.
Mount Vernon Springs, Mount Vernon Springs, Chatham County.
Panacea Spring, Warren County, near Littleton.
Parks Springs, Caswell County, near Danville, Va.
Seven Springs, Sevensprings, Wayne County.
Shelby Lithia Spring, Shelby, Cleveland County.
Smith Lithia Spring, Oxford, Granville County.

1914

"The sales of mineral water in North Carolina in 1914 amounted to 158,226 gallons, valued at $21,964, as compared with 176,068 gallons, valued at $23,877, in 1913, a decrease of 10 per cent in quantity and of 8 per cent in value. The average price per gallon remained 14 cents, as in 1913. Ten resorts, accommodating 1,650 guests, and 3 establishments for bathing in mineral water were maintained at springs. A small quantity of water also was used in the manufacture of soft drinks.

"The same springs, 17 in number, were active during 1913, and the names and locations of them follow:

All Healing Spring, Taylorsville, Alexander County.
Barium Rock Spring, Barium Springs, Iredell County.
Buckhorn Lithia Spring, Bullock, Granville County.
Connelly Springs, Connelly Springs, Burke County.
Derita Mineral Spring, Derita, Mecklenburg County.
Haywood White Sulphur Spring, Waynesville, Haywood County.
Huckleberry Spring, Durham, Durham County.
Jackson Springs, Jackson Springs, Moore County.
Midas Spring, near Huntersville, Mecklenburg County.
Moores Springs, Moores Springs, Stokes County.

Mount Vernon Springs, Mount Vernon Springs, Chatham County.
Panacea Spring, Warren County, near Littleton.
Parks Springs, Caswell County, near Danville, Va.
Seven Springs, Sevensprings, Wayne County.
Shelby Lithia Spring, Shelby, Cleveland County.
Smith Lithia Spring, Oxford, Granville County.
Vade Mecum Spring, Vade Mecum, Stokes County.

1915

"The mineral water business in North Carolina decreased 16 per cent in quantity and 15 per cent in value during 1915, and the average price remained the same—14 cents. The total sales amounted to 132,813 gallons, valued at $18,745, as compared with 158,226 gallons, valued at $21,964, in 1914. A small quantity of mineral water also was consumed in the manufacture of soft drinks. Twelve resorts, accommodating 1,900 guests, and two establishments for bathing in mineral water were maintained at springs. Production was reported for the first time from Bromine Arsenic Lithia Springs. One spring active in 1914 concerning which no report was received in 1915 was considered idle.

"The 17 springs that reported production are as follows:

All Healing Spring, Taylorsville, Alexander County.
Barium Rock Spring, Barium Springs, Iredell County.
Bromine Arsenic Lithia Springs, Crumpler, Ashe County.
Buckhorn Lithia Spring, Bullock, Granville County.
Connelly Springs, Connelly Springs, Burke County.
Derita Mineral Spring, Derita, Mecklenburg County.
Haywood White Sulphur Spring, Waynesville, Haywood County.
Huckleberry Spring, Durham, Durham County.
Jackson Springs, Jackson Springs, Moore County.
Midas Spring, near Huntersville, Mecklenburg County.
Moores Springs, Moores Springs, Stokes County.
Mount Vernon Springs, Mount Vernon Springs, Chatham County.
Panacea Spring, Warren County, near Littleton.
Parks Spring, Caswell County, near Danville, Va.
Seven Springs, Sevensprings, Wayne County.
Shelby Lithia Springs, Shelby, Cleveland County.
Vade Mecum Spring, Vade Mecum, Stokes County."

1916

"The mineral water business in North Carolina remained practically the same in 1916 as in 1915, and the average price per gallon remained the same—14 cents. The sales amounted to 137,817 gallons, valued at $19,010, as compared with 132,813 gallons, valued at $18,745, in 1915. No mineral water was consumed in the manufacture of soft drinks.

Twelve resorts, accommodating about 1,700 guests, and three establishments for bathing in mineral water were maintained at springs. Derita Mineral Spring is now known as Derita Calcic Spring.

"The 19 springs that reported production are as follows:

All Healing Spring, Taylorsville, Alexander County.
Barium Rock Spring, Barium Springs, Iredell County.
Bromine Arsenic Lithia Springs, Crumpler, Ashe County.
Buckhorn Lithia Spring, Bullock, Granville County.
Connelly Mineral Spring, Connelly Springs, Burke County.
Derita Calcic Spring, Derita, Mecklenburg County.
Haywood White Sulphur Springs, Waynesville, Haywood County.
Huckleberry Springs, Durham, Durham County.
Jackson Springs, Jackson Springs, Moore County.
Mildas Spring, near Huntersville, Mecklenburg County.
Moores Springs, Moores Springs, Stokes County.
Mount Vernon Springs, Mount Vernon Springs, Chatham County.
Panacea Springs, Warren County, near Littleton.
Parks Spring, Caswell County, near Danville, Va.
Seven Springs, Sevensprings, Wayne County.
Shelby Lithia Springs, near Shelby, Cleveland County.
Sherrill Mineral Springs, near Cabarrus, Cabarrus County.
Smith Lithia Springs, near Oxford, Granville County.
Vade Mecum Spring, Vade Mecum, Stokes County."

1917

There was a decrease in the mineral water business in North Carolina in 1917 as compared to 1916, though there was a slight increase in the average price per gallon, which was 15 cents in 1917 and 14 cents in 1916.

There were 18 active springs during 1917, one being a new spring, the Rivermont Carbonated Spring of Durham County. The following are the springs which reported a production in 1917:

All Healing Spring, Taylorsville, Alexander County.
Barium Rock Spring, Barium Springs, Iredell County.
Bromine Arsenic Lithia Springs, Crumpler, Ashe County.
Buckhorn Lithia Springs, Bullock, Granville County.
Connelly Mineral Spring, Connelly Springs, Burke County.
Derita Calcic Spring, Derita, Mecklenburg County.
Haywood White Sulphur Spring, Waynesville, Haywood County.
Huckleberry Springs, Durham, Durham County.
Jackson Springs, Jackson Springs, Moore County.
Midas Springs, near Huntersville, Mecklenburg County.
Moores Springs, Moores Springs, Stokes County.
Mount Vernon Springs, Mount Vernon Springs, Chatham County.
Panacea Springs, Warren County, near Littleton.
Parks Spring, Caswell County, near Danville, Va.
Rivermont Carbonated Spring, near Durham, Durham County.

Seven Springs, Sevensprings, Wayne County.
Shelby Lithia Springs, near Shelby, Cleveland County.
Smith Lithia Springs, near Oxford, Granville County.
Vade Mecum Spring, Vade Mecum, Stokes County.

Production

The table below gives the quantity and value of mineral waters which were put on the market for 1901-1917, inclusive:

PRODUCTION OF MINERAL WATERS IN NORTH CAROLINA
1901—1917, INCLUSIVE

Year	Amount, Gallons	Value
1901	375,700	$ 42,167
1902	104,400	18,795
1903	83,100	13,085
1904	145,800	21,902
1905	201,000	38,755
1906	158,680	31,413
1907	193,479	40,302
1908	171,395	27,163
1909	128,171	20,558
1910	143,007	21,389
1911	231,510	31,108
1912	144,708	22,385
1913	176,068	23,877
1914	158,226	21,964
1915	182,813	18,745
1916	137,817	19,010
1917	103,659	15,664

Producers of Mineral Waters During 1917

All Healing Springs, care
O. F. Pool................Taylorsville, Alexander Co., N. C.
Vitalizer Mineral Springs
Co., care John B. Ross...Charlotte, N. C., Springs at Barium Springs, Iredell County.
Bromine-Arsenic Lithia
Springs ....Abingdon, Va., Springs in Ashe County, North Carolina.
Buckhorn Lithia Water Co.Bullock, Granville County, N. C.
A. H. Alexander...........Derita, R. F. D. 14, Mecklenburg County, N. C.
Mrs. J. L. Morgan, Haywood
White Sulphur Springs...Waynesville, Haywood County, N. C.
J. J. Riley................302 Milton Ave., Durham, Durham County, N. C.
J. L. and Frank Page......Jackson Springs, Moore County, N. C.
Midas Spring Water Co....218 E. Fifth St., Charlotte, Mecklenburg County, N. C.
Moores Spring Mineral Co.Moores Springs, Stokes County, N. C.

Mt. Vernon Mineral Water Co. .... Mt. Vernon Springs, Chatham County, N. C.
Panacea Springs Co....... Littleton, R. F. D. 1, Warren County, N. C.
Parks Spring Water Co.... Danville, Va., R. F. D. 5, Springs in Caswell County, N. C.
Dr. R. L. Holloway......... West Durham, Durham County, N. C.
Raymond Maxwell .... Sevensprings, Wayne County, N. C.
Shelby Lithia Water Co., care H. B. Quinn......... Shelby, Cleveland County, N. C.
Smith Lithia Water Co..... Oxford, Granville County, N. C.
J. Cicero Tise .... Winston-Salem, N. C., Springs at Vade Mecum, Stokes County, N. C.

FELDSPAR

"The feldspars are among the most widely distributed minerals and occur as constituents of nearly all igneous rocks. In most rocks, however, feldspar is in too small grains and is too intimately associated with other minerals to be of commercial importance. Commercially valuable feldspar usually occurs as a constituent of pegmatite—rocks of extremely coarse grain and irregular texture. In mineral composition, pegmatites vary greatly, but those of present commercial importance belong generally to two types: (1) the granite pegmatites or "giant granites," composed essentially of feldspar, quartz, and mica; and (2) the soda pegmatites which consist mainly of soda feldspar (albite) and small quantities of hornblende. By far the larger number of the feldspar quarries of the United States are in deposits of granite pegmatite. These granite pegmatites contain, besides feldspar, the following minerals in abundant proportions: quartz, muscovite (white mica), biotite (black mica), and black tourmaline. Generally less abundant are garnet, magnetite and beryl.

"The potash and potash-soda feldspars mined in the United States are mostly pale flesh color to nearly white. Some are reddish and pearly gray. Soda feldspars and soda-lime feldspars are commonly pure white or light gray and pale green in color. When finely ground, all commercial feldspars are either white or very pale pink.

"Feldspar is used principally in the manufacture of pottery, chinaware, porcelain, enamel ware, and enamel brick and tile. It is used in both the body and the glaze on ceramic products. As an abrasive, it is usually a constituent of scouring soaps and window wash. Other uses of feldspar which do not require high grade material are in the manufacture of emery and corundum wheels, where it serves as a binder; in the manufacture of glass; as a poultry grit; as a constituent of roofing material; and for surfacing concrete work. Small quantities

of the purest grades of potash feldspar are used in the manufacture of artificial teeth. For this latter purpose it brings the highest prices—$6 to $8 a barrel of 350 pounds.

"The use of ground feldspar as a fertilizer has been proposed and many tests have been made by the United States Department of Agriculture. This is of particular interest at this time in view of the great need for potash for agricultural purposes. It may be stated here that one company in North Carolina has recently reported that they have perfected a process for the extraction of potash from the feldspar.

"The requirements of the pottery trade demand that in general the percentage of free quartz associated with the feldspar used for this purpose shall not exceed 20 per cent in the ground product, and certain potters demand a spar which is nearly pure, containing probably less than 5 per cent of free quartz. A factor of the utmost importance in the mining of pottery spar is the quantity of iron-bearing minerals (black mica, hornblende, black tourmaline, etc.) present and the manner in which these minerals are associated with the feldspar. The requirements of the pottery trade demand that the spar be nearly free from these minerals.

"Feldspar is a common mineral in North Carolina as a constituent of all granites and gneisses and of pegmatitic dikes. A great deal of it, however, found near the surface, especially in the southern counties, has been either partially or wholly kaolinized so that it is not of value as a feldspar for pottery manufacture; but in many cases, has formed extensive beds of kaolin. In the northern counties, however, fresh, unaltered feldspar occurs in quantity. These are found for the most part as constituents of pegmatitic dikes that are being worked for mica, and most of the mines now producing feldspar or kaolin were formerly opened as mica mines. In fact, in a great many of the feldspar mines mica and kaolin are obtained as by-products. The principal feldspar mines now being worked are in Avery, Mitchell and Yancey Counties, principally in the vicinity of Spruce Pine, Plumtree and Penland, Mitchell County; and Dobag, Micaville and Burnsville, Yancey County. There are regions of Iredell, Lincoln and Cleveland and of Jackson, Macon and Swain counties where there are particularly promising prospects."

The following notes in regard to North Carolina Feldspars taken from Bulletin 92 of the United States Bureau of Mines on "The Feldspars of the New England and north Appalachian States," by A. S. Watts, published in 1916:

"The feldspar deposits of North Carolina are distributed throughout the mountain section southeast of the Great Smoky Mountains. The most prom-

ising districts are those described in Bulletin 53 of the Bureau of Mines[1] as the Cowee district and the Sprucepine district. The former includes parts of Jackson, Macon, and Swain counties and the latter includes parts of Yancey, Mitchell, and Avery counties. The feldspars throughout this State are, as a rule, cream white microclines with very low soda content. A few small deposits of soda feldspar and anorthoclase were noted but the great majority of deposits in North Carolina are of potash feldspar, most of it being extremely coarse pegmatite, and, as the field is new, a large amount of pure feldspar is to be found as lenses in the pegmatite. Many of the pegmatites are so coarsely crystalline that the quartz content can be almost entirely removed by cobbing. The dikes are seldom large, however, and as most of them stand almost vertical, the problem of mining is more difficult than where the deposits are large lenses or lie nearly flat, as is the case with many deposits farther north. The chief impurities are quartz and muscovite, with smaller amounts of biotite, beryl, and garnets. The latter three minerals, however, are seldom present in quantity sufficient to affect injuriously the color of the product, and the muscovite is generally coarsely crystalline and not generally distributed throughout the entire mass. The mining in the Cowee district is confined to mining for mica and no attempt is made to remove the feldspar except where it interferes with the mining of the mica. In the Sprucepine district, three feldspar quarries are now in operation and others are to be opened in the near future. The potash feldspars of North Carolina may be safely represented by the following analyses:

ANALYSES OF POTASH FELDSPARS OF NORTH CAROLINA.

(D. J. Demorest, Analyst.)

Constituent	A	B	C	D	E
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Ignition loss	0.90	0.17	0.60	0.30	0.40
SiO_2	64.48	65.37	63.90	65.68	64.93
Al_2O_3	19.43	17.92	19.97	19.08	19.45
Fe_2O_3	.01	.02	.15	.14	
CaO		.17	.05		.05
MgO					
BaO			.70		
K_2O	13.19	13.05	13.20	13.09	12.46
Na_2O	1.84	2.10	1.01	2.08	2.54
Totals	99.85	98.80	99.58	100.37	99.83

The following article on "Feldspar and Kaolin in the Clinchfield Territory"*, by W. H. Kemler, Industrial Engineer of the Carolina, Clinchfield & Ohio Railway, will be of interest:

[1]Watts, A. S., Mining and treatment of feldspar and kaolin in the Southern Appalachian region: Bull. 53, Bureau of Mines, 1913, p. 12.
**Manufacturer's Record*, July 31, 1913, volume 64, page 51.

Feldspar and Kaolin in the Clinchfield's Territory

"The present greatest general interest in connection with exploratory work and mineral development projected and under way in the territory of the Carolina, Clinchfield & Ohio Railway probably is evidenced just now by the activity in the feldspar and kaolin belt, on the west slope of the Blue Ridge and east slope of the Black Mountains, in Mitchell and Yancey Counties, North Carolina.

"Unceasing energy is being displayed in exploring virgin ground, and a number of large and important factors in the feldspar-producing business are preparing to develop these extensive deposits of highgrade potash feldspar, the value to the ceramic and kindred industries having been established during the past 12 months by the consumption of nearly 7,000 tons of this feldspar in Northern and Eastern markets in competition with the feldspar mined in Maine, Connecticut, New York, Pennsylvania, Maryland, and Canada.

"The topographic location of these deposits, their proximity to the railway, ease in mining and ready access to the markets of the Eastern and North Central States, warrant the belief that this valuable mineral resource is destined to create a new center for a large mining development, and particularly so in the event of a successful commercial method of potash extraction from feldspar being evolved.

"Recent progress in this direction indicates that several well known patented processes can be developed under conditions that assure success and which would labor under adverse conditions in other less favored spar districts.

"The occurrence in this territory of secondary minerals essential to the operation of these processes, such as barytes, gypsum, fluorspar, salt, limestone, etc., combined with ready sources of the various acids, by-products, cheap fuel, hydro-electric power and other facilities for chemical manufacture, makes the successful development of this much-sought fertilizer agent one of great commercial importance.

"Such a potash production would stimulate other lines of chemical development, and the manufacture of many other valuable combinations of potassium salts and compounds would follow in the South.

"A ready market for potash salts is evidenced by the enormous consumption of the imported salts by the fertilizer and other industries of the Southern States, and it only remains for capital to investigate the potentiality of these large resources, their ease of development and the profitable returns that can be realized from their development.

"Extensive experimental work to the point of semi-commercial plant installations is now being conducted in the East by men identified with the chemical progress of this country, and while many heretofore have sought but the extraction of the potash alone, which would not pay, the prominent research investigators hereafter mentioned have not lost sight of the valuable by-products produced in their processes and the putting of these by-products into marketable form, and upon these features the future commercial success of potash extraction from feldspar is dependent. The several processes

patented by Professor Hart, of Lafayette College; Professor Morse, of the University of California, and Professor Doremus, of New York City, and which undoubtedly represent the best practical methods evolved, can all be worked under exceptionally flattering economic conditions, and it is manifest to those conversant with such chemical research work that any future development along these lines will be concentrated south of the Ohio River and in the immediate territory adjacent to the basic minerals required, as well as cheap power and labor.

"Kaolin, or china clay, has been produced for almost a decade along that portion of the Clinchfield route formerly known as the South and Western Railway, the mines and washing plants being located at Spruce Pine and Penland, N. C., these developments being confined to one company, and the superiority of this type of china clay is now well established. However, increased expansion of the ceramic industry throughout the United States, the decrease in imported kaolins and the exhaustion of similar clay deposits in other districts justifies further development of this excellent raw product, as it stands second to none thus far mined in this country.

"Many deposits advantageously located occur tributary to the railway in its Mitchell and Yancey County (North Carolina) mileage.

"These clays are residual, that is, formed at the point they originated through the decay of pure veins of feldspar, pegmatite or granite, and their initial purity varies according to the contaminations which occur in the vein from which they were formed.

"The commercial extent of any deposit can be easily determined by sinking test pits and by drilling. Those now being worked are vein formations of considerable length, whose depth is comparatively great as relative to their width. The accessibility of these deposits does not depend entirely upon distance from the railway, as the crude clay can be transported in almost every case to a washing plant by sluicing with water, the supply of which is normally fulfilled by the mountain streams, and can be carried long distances, as fairly steep and uniform grades between the deposits and water is available, and the deposits being, as a rule, located at considerable heights above the railway, no difficulty in handling the clay by this system would be encountered with.

"Renewed interest is being directed to these valuable deposits, and it is reasonably expected that the development along these lines will increase as the commercialization of these clays becomes more common and modern engineering methods replace the obsolete means of preparing the clays that now prevail. This wonderful resource is well deserving of increased exploitation, and the success of the plants now in operation might be excelled through development in accordance with modern ideas.

"The evolution of a cheap and satisfactory method of extracting alumina from kaolin would mean increased stimulation in the production of these clays, and it is becoming cognizant to those identified with industrial research that the solution of this problem is not far distant and will be one of practicability.

"To the progressive factor, seeking an outlay for capital, no better field for investment can be located, and the future of this industry is exceptionally bright in view of the fact that the ceramic industry is gradually pointing South, the foundation for both raw materials and future markets."

Production

North Carolina first began producing feldspar in 1911, at which time the Carolina Mineral Company of Penland, Mitchell County, was the only producer. At that time North Carolina had sixth place in the production of the United States. In 1913 it was again sixth in the production by States, the output being almost entirely from two companies in the Spruce Pine district, Mitchell County. In 1914 North Carolina had sixth place in value and fifth place in quantity. The output was reported by four operators in the Spruce Pine district of Mitchell County, and amounted to 15,420 tons, valued at $43,153. In 1915 North Carolina was third in the order of production, with an output of 20,635 long tons, valued at $55,991. In 1916 there was produced in North Carolina 30,955 long tons, valued at $77,446, North Carolina being second among the states in the order of its production. In 1917 North Carolina ranked first in the quantity and second in value among the states of the country in its production of feldspar. Reports of production were received from 24 quarry operations, chiefly in the Spruce Pine district in Mitchell, Avery and Yancey counties. The total output was 42,463 tons, valued at $131,442. Prices ranged from $2.60 to $7.00 a ton, averaging $3.10. Much of the output was ground at Erwin, Tennessee, and the remainder went chiefly to mills at East Liverpool, Ohio, and Trenton, New Jersey.

Feldspar Mills

It may be of interest to have the names and addresses of mills operated by feldspar consumers for grinding spar for their own use. The following are mills in the eastern states operated by dealers in feldspar at the places named:

Maine Feldspar Co., Auburn and Topsham, Maine; Trenton Flint and Spar Co., Cathance, Maine; Louis W. Howe, South Glastonbury, Conn.; Bedford Mining Co., Bedford, N. Y.; Pennsylvania Feldspar Co., Barnard, N. Y., and Toughkenamon, Pa.; Brandywine Summit Kaolin & Feldspar Co., Brandywine Summit, Pa.; Eureka Flint & Spar Co., Trenton, N. J.; Golding Sons Co., Trenton, N. J., Wilmington, Del., and East Liverpool, Ohio; Potters Mining & Milling Co., East Liverpool, Ohio; Newell Mining & Pulverizing Co., Newell, W. Va.; Clinchfield Products Corporation, Erwin, Tenn.; and Rochester Feldspar Mills (Inc.), Rochester, N. Y.

Producers of Feldspar During 1917

Edward Blake.................Newdale, Yancey County, N. C.
Carolina Mineral Co............Penland, Mitchell County, N. C.

Carolina Spar & Mica Co........Forbes, Mitchell County, N. C.
Cedar Cliff Spar Co.............Tile Station, Zanesville, Ohio. Near Micaville, Yancey County, N. C.
Clinchfield Products Corporation..........................100 Williams Street, New York, N. Y. Kona, Mitchell County, N. C.
Eureka Flint and Spar Co.......Trenton, N. J., and Penland, Mitchell County, N. C.
F. G. Ganett
Hall and McMahon
R. B. Harrison..................Spruce Pine, Mitchell County, N. C.
Hickey & Turbyfill
Geo. W. Owens..................Greenmountain, Yancey County, N. C.
Mrs. J. H. Phillips
S. L. Phillips
T. C. Robinson
U. S. Development Co..........Lunday, Mitchell County, N. C.
Carl Williams, Jr...............Toecane, R. 1, Mitchell County, N. C.
Carolina Products Co...........Bandana, Mitchell County, N. C.
Glass Brick Co..................Huntington, W. Va. Kona, Yancey County, N. C.
Wiseman Mines Corporation....Spruce Pine, Mitchell County, N. C.
Z. C. Harris....................Windom, Yancey County, N. C.
H. C. Smith.....................Burnsville, Yancey County, N. C.
Toe River Mining Co.
Empire Mineral Co.............Estatoe, Mitchell County, N. C.
E. F. Watson

COAL

On the land of Mr. C. T. Garrett, about three miles from Hot Springs and three-fourths mile up Jack's Creek from the French Broad River, prospecting has been done for coal. This was first carried on about the year 1899 on the west side of Jack's Creek where a tunnel about 180 feet long was opened. About 1910 or 1911 two more tunnels were opened, one of them on a seam 40 feet below the upper one and five feet above the level of water in the creek. At another time a tunnel was dug eastward along the seam on the opposite side of the creek and a little farther up. In August, 1915, work was again begun on the upper seam and continued somewhat regularly until July, 1916. This tunnel was about 140 feet long and was drained with a siphon while the work was being done. In all, five tunnels have been dug.

So far as reported, there has been no production of coal in North Carolina since 1912. There have been reports, however, of revived interest in the Cumnock sections of Lee and Chatham counties, and in 1917 the Lee Coal Mining Company of Southern Pines was chartered for developing these properties. It is expected that opera-

tions will begin in 1918. A sample of coal from one of their openings was analyzed by the U. S. Bureau of Mines, with the following results:

Moisture (as received)	1.6
Volatile matter (dry coal)	33.9
Fixed Carbon (dry coal)	59.1
Ash (dry coal)	7.0
Sulphur (dry coal)	2.15
British Thermal Units (as received)	13,870
British Thermal Units (dry coal)	14,090

The old Egypt mine has been opened up, and it is expected that during 1918 this mine will become a producer.

There is given in the table below the production of coal in North Carolina since 1890:

COAL PRODUCTION IN NORTH CAROLINA FROM 1890 to 1917.

Year	Quantity
	Long Ton
1890	10,262
1891	20,355
1892	6,679
1893	17,000
1894	16,900
1895	24,900
1896	7,813
1897	21,280
1898	11,495
1899	26,896
1900	17,734
1901	12,000
1902	23,000
1903	17,309
1904	7,000
1905	1,557
1906	-------------
1907	-------------
1908	-------------
1909	-------------
1910	-------------
1911	-------------
1912	120
1913	-------------
1914	-------------
1915	-------------
1916	-------------
1917	-------------

GRAPHITE

Graphite is known to occur at many localities within the area of crystalline rocks in the central and western parts of North Carolina.

A number of years ago an unsuccessful attempt was made by the Southern Graphite Company to work a graphite deposit near Graphiteville, McDowell County.

In 1911, Charles Rennie of Franklin, N. C., reported the occurrence of clay graphite four miles west of Franklin. A few tons were shipped for treatment to the Federal Graphite Company at Warren, Ohio.

In 1912, a few tons of graphitic schist were mined at Barrett's Mountain in Alexander County, but none was refined or shipped.

There was no production of graphite reported from North Carolina for 1913, 1914 or 1915.

In 1916, there was a small output of amorphous graphite mined in Catawba County by the Aetna Graphite Company of Columbus, Ohio. H. M. Ashe & Company of Atlanta, Ga., prospected graphite deposits in Macon County.

There was no report of a production of graphite in the State during 1917. There was, however, a report of the discovery of a graphite mine on the plantation of Mr. W. A. Spangle, about 4 miles northwest of Shelby in Cleveland County, and it is reported that Mr. Spangle has leased this property to the General Graphite Company for a period of three years. This mine is expected to be a producer in 1918. It is also reported that a graphite plant is to be erected at Shelby for the purpose of utilizing the numerous pockets of graphite in Cleveland and adjoining counties.

RARE MINERALS

Associated with the pegmatites of Mitchell and Yancey counties are several rare minerals which have commercial value. Among these is the mineral pitchblende or urananite. In Mitchell County small quantities occur near Penland in the quartz and feldspar mines. The mineral is usually associated with quartz, but in places with orthoclase feldspar, and still more frequently, with albite. Its presence is usually indicated by a dull green stain on the quartz or spar, although such stains do not invariably mean that ore is present. The pitchblende from near Penland is usually high grade and is found associated with yellow gummite. In probably the best mine only 50 pounds have been found in one and a half years; so that as yet the mining of these deposits cannot be considered a commercial enterprise. The ore is usually sold in small quantities, as museum specimens. No production of rare minerals has been reported for North Carolina during the period covered by this report, except a small production of samarskite in 1914.

GREENSAND

Because of the shortage in potash which the United States has recently experienced, there has been a special search made for new sources of supply in this country and for possible methods of utilizing

the mineral deposits containing potash. A report was made for the United States Geological Survey by Mr. George H. Ashley on "Notes on the Greensand Deposits of the Eastern States," supplemented by a report on "Methods of Analysis of Greensand" by William B. Hicks and Reginald K. Bailey. This is published as Bulletin 660-B of the United States Geological Survey.

While North Carolina has, so far as known, only a limited quantity of this material, yet because of the importance of discovering new sources of supply a brief sketch is given here with such data as has been assembled in regard to North Carolina deposits with the idea of creating such interest as may lead to the discovery of other deposits in this State. In his general introduction, Mr. Ashley says:

"Potash is exceedingly abundant in the earth's crust, but usually forms only a small percentage of the rock containing it. Most granites, for example,[1] contain 4 to 8 per cent of potash, and a few of the nephelite and leucite rocks contain over 9 per cent of potash. Many of the rhyolites, porphyries, trachytes, syenites, monzonites, and basalts contain more than 5 per cent of potash. Some minerals, such as sylvite (52.4 potassium) and niter (46.5 potash), contain more than 20 per cent, theoretically, of potash or of potassium, but these minerals are relatively rare in this country and have not yet been found in quantities large enough to be of commercial interest. A few other minerals, such as leucite, alunite, orthoclase, muscovite, biotite, and lepidolite, contain 4 to 16 per cent of potash, averaging about 8 per cent. These are the minerals for which special search has been made. At least one large deposit of leucite-bearing rock averaging about 10 per cent of potash is known in Wyoming, and a claim has been filed on it. Small but workable deposits of alunite, carrying 7 to 11 per cent of potash, have been found in Utah and adjoining States. Small deposits of sericite (muscovite) schist, carrying 5 to 8 per cent of potash, are known in Georgia and the Carolinas. The other minerals mentioned are abundant but are commonly scattered through the rocks as isolated crystals or occur as thin veins or stringers, so that though selected specimens may yield 10 per cent or more of potash, the quantity of such minerals in any body so far known that will maintain an average that high is relatively insignificant.

"In their extent and availability these resources of potash-bearing minerals or rocks present a strong contrast to the greensands of Eastern states, which underlie the surface of hundreds, if not thousands, of square miles within reach of the steam shovel, and which range in thickness from a few feet to 30 feet and carry 5 to 7 per cent of potash. As a cubic foot of greensand weighs about 90 pounds and (if 7 per cent material) contains 6.3 pounds of potash, a square mile of sand 1 foot thick will yield 78,000 tons of potash. A 20-foot bed that covers a square mile should yield 1,500,000 tons of potash; a 20-foot bed of 5 per cent greensand should yield 1,000,000 tons to the square mile and should also carry about 2,000,000 tons of iron, and possibly 500,000

[1]Clarke, F. W., The data of geochemistry, 3d ed.: U. S. Geol. Survey Bull. 616, pp. 433 et seq., 1916.

tons of phosphoric acid. The figures given apply to the best sands only, but if the samples taken indicate the character of the sand throughout the full thickness of the bed there are many square miles of greensand containing 7 per cent of potash and perhaps hundreds of square miles containing 4 or 5 per cent. In view of the possible ease of mining these sands they would seem to offer an adequate source of potash for perhaps several hundred years, provided a cheap method of extracting the potash can be found.

"The object of this paper is to place before chemical engineers and others succinct information as to the location and extent of easily accessible greensand deposits in the Eastern States and their content of potash, and thus to provide an answer for many inquiries made of the United States Geological Survey. The paper brings together the results of analyses of samples of greensand that were collected by W. C. Phalen and the writer, and analyzed in the chemical laboratory of the United States Geological Survey by W. B. Hicks and R. K. Bailey and gives notes on the occurrence and extent of the beds sampled. It will be noted that the analyses do not substantiate many older analyses of glauconite, the potash-bearing mineral in greensand, which gave 11 and 12 or even 14.5 per cent of potash. All modern analyses indicate that glauconite contains only 7 to 8 per cent of potash.

"The samples were taken from deposits that lie near transportation lines, either rail or water, and that could be handled cheaply, in large quantities, either by the steam shovel or dredge or other mechanical means. These limitations to the study were set in the belief that the demand for potash is urgent and possibly only temporary, and that what is immediately desired is rather information as to the best and most available deposits for possible utilization than a comprehensive report that would be of value in the development of the industry.

"After a brief review of the available information concerning the greensand deposits of the eastern United States, either published or unpublished, a number of the most promising deposits were selected for study. When the selection had been made Mr. Phalen visited areas in New Jersey, and the writer visited areas in Delaware, Maryland, Virginia, North Carolina, Tennessee, and Arkansas.

"In general, the results show that the best and most available deposits are in New Jersey and Delaware, samples from which yielded from 3.50 to 7.15 per cent of potash, the highest percentages coming from deposits in New Jersey. The samples from Maryland yielded 4.45 per cent or less; the samples from Virginia, which contained much lime, yielded 2 to 2.50 per cent; those from North Carolina 2.96 or less, and those from Arkansas 4.90 per cent or less. No glauconite sand was found in Tennessee in the area from which it had been reported by Troost.[1] Since the above was written it has been learned that a little greensand containing not over 3 per cent of potash has been found by Mr. Bruce Wade in McNairy County, Tenn., at the foot of a hill west of Adamsville."

"Origin and Nature of Greensand

"The origin of greensand is still somewhat in doubt, but there is good reason for believing that it is a product of the alteration of clay or feld-

[1]Troost, Gerard, Seventh report of the Geological Survey of Tennessee, p. 1844.

spar, particularly clay. The steps assumed by Murray and Irvine[1] are, first, the formation of iron sulphide in sea water in the presence of decomposing vegetable matter and, second, the replacement of the aluminum of the clay by this iron, resulting in a compound that combines with the potash in sea water to form glauconite, the potash in the sea water having been derived from potash feldspars, mica, and other potash bearing minerals that are brought into the sea. Some water also enters into the glauconite molecule. According to Murray and Renard,[2] the sulphates in sea water act on the iron in mud or clay in the presence of organic matter, producing iron sulphide, which later oxidizes to the hydroxide. At the same time the alumina is removed from the clay by solution, and colloidal silica is liberated, which reacts upon the ferric hydroxide in the presence of potassium salts extracted from the adjacent minerals, the reaction forming glauconite.

"As a consequence of variations in the conditions under which glauconite is formed the process of formation does not appear to be very uniform or to produce a single definite compound, for the alumina may not be completely removed and the potassium may be in part replaced by other bases. If the glauconite were pure and had the formula suggested by Dana, $Fe'''KSi_2O_6+3H_2O$, it should contain 13 per cent of potash. As a matter of fact, the analyses quoted indicate that some of the potassium is always replaced by other bases.

"The most common type of glauconite consists of minute botryoidal pellets whose forms are due, apparently, to the fact that the clay from which they were derived occupied cavities in minute shells. The pellets in another type are round and smooth, as if they had been derived by erosion and redeposition from a deposit of the first type. A third type, which includes glauconite stains and the grains that fill crevices and cavities, may be due, in part, to the alteration of grains of feldspar.

"Glauconite is found in deposits on the sea bottom at depths ranging from about 300 feet to 2 miles.

"Recently formed glauconite is well described and illustrated in the report of the *Challenger* expedition.[3] Some of the deposits found by that expedition were almost pure glauconite. Most of the deposits found, however, contained from 40 to 50 per cent of foraminiferous and other calcitic shells. The grains of recent glauconite rarely if ever exceed 1 millimeter in diameter, and are typically rounded or mammillated, hard, and black or dark green. The surface of some of the grains is dull, that of others is shiny. Many of the grains have vaguely the form and appearance of Foraminifera and other organisms. Mixed with these typical grains are many pale-green particles that have the distinct impress of calcareous shells, many being obviously internal casts."

"NORTH CAROLINA

"The Greensand of North Carolina was sampled at only one locality—a bluff one mile above Edwards Bridge, on the north side of Contentnea Creek, about 6 miles above Grifton, a station on the Atlantic Coast Line Railroad

[1]Collect, L. W., Les depots marins, p. 169, Paris, 1908. See also Murray, John, and Irvine, Robert, On the chemical changes which take place in the composition of the sea water associated with blue muds on the floor of the ocean. Roy. Soc. Edinburgh Trans. vol. 27, pt. 3, 1893.

[2]Murray, J., and Renard, A. F., Challenger Rept., Deep-sea deposits, p. 389, 1891.

[3]Idem, pp. 378 et seq.

a few miles northeast of Kingston. The greensand at this point was said by L. W. Stephenson to appear to be much greener than any other that he had seen in the State. It is overlain by 6 to 8 feet of clay and yellow sand and gravel. The richer portion of the sand is 4 feet thick. Sample 43, taken at this locality, is a light-greenish sand, containing considerable quartz. Below the layer sampled lies 8 feet of dark-gray sand, which here and there contains small stringers of greensand a few inches long and less than an inch thick. Sample 44 represents a 7-foot cut in this bed.

"The greensand is reported to have been struck in ditches some distance north and east of this bluff. About a quarter of a mile above Edwards Bridge, nearly 5 feet of the lower bed is exposed in a bluff on the north bank. The greensand is overlain directly by the surface sand and gravel. The lower bed at this point is represented in sample 45."

Results of analyses of samples collected from North Carolina are as follows:

Analyses of Greensands

(By W. B. Hicks and R. K. Bailey, Analysts.)

No.	Locality	Potassium	Potash	Analyst
43	Contentnea Creek, N. C.	2.46	2.96	Bailey.
44	Contentnea Creek, N. C.	1.14	1.37	Bailey.
45	Contentnea Creek, N. C.	1.12	1.35	Bailey.

STONE

The development of the stone industry in North Carolina has been most interesting, and the production has increased almost constantly from year to year since the industry began to be thoroughly advertised and the various stones became known. In 1897 the value of the stone produced in North Carolina was less than $75,000; in 1916, the year of record production, the total production of stone reached near $2,000,000. This has been due in large part to the increase in the production of granite. Under the head of "Stone" is included all granite, no matter for what purpose used; sandstone; marble and other forms of limestone, including that which is made into lime or used as limestone for agricultural purposes, this also including the marls of the Coastal Plain. In recent years stone has come to be used very largely in the making of concrete, and a large proportion of the stone from some of the quarries is used entirely for this purpose. The manufacture of paving blocks has also grown very extensively, and many of the companies are developing certain types of block under trade names. In the table below there is given the value of the production of the various stones produced in North Carolina from the year 1900 to 1917, inclusive:

PRODUCTION OF BUILDING STONES IN NORTH CAROLINA, 1900—1917.

Year	Granite	Sandstone	Marble and Limestone	Total Value
	Value	*Value*	*Value*	
1900	$ 257,962	$ 27,210	$*	$ 285,172
1901	264,906	11,682	8,357	284,945
1902	338,749	4,825	23,153	366,727
1903	334,357	600	25,365	360,322
1904	292,439	250	19,887	312,576
1905	564,425	4,482	29,015	597,922
1906	778,819	3,431	72,051	854,301
1907	906,476	4,105	46,338	956,919
1908	771,522	†	53,405	824,927
1909	743,876		106,931	850,807
1910	837,742	†	77,585	920,027
1911	772,685	†	81,651	864,071
1912	983,615	†	100,766	1,090,831
1913	1,116,475	†	140,364	1,260,339
1914	1,286,345	†	154,888	1,452,405
1915	1,246,810	27,544	164,344	1,438,698
1916	1,798,087	†	176,164	2,026,782
1917	1,486,541	†	‡ 233,950	‡ 1,948,539

*Statistics not collected for 1900. †Included in total production. ‡Includes a production of Rhyolite.

Granite

The largest and most extensively worked granite area in the State is the Mt. Airy granite area in Surry County, North Carolina. This has been described in considerable detail in Bulletin 2 and Economic Paper 34 of the publications of the North Carolina Geological and Economic Survey, as well as other important granite areas of the State.

Production

During 1913 there were 27 operators who quarried in the following eleven counties, given in the order of the importance of their productions: Surry, Rowan, Mecklenburg, Rockingham, Buncombe, Warren, Polk, Vance, Wilson, Gaston and Henderson. The value of the 1913 production was $1,116,475.

In 1914 there were 38 operators who quarried in the following sixteen counties, given in the order of the importance of their productions: Surry, Rowan, Stanly, Rockingham, Wake, Mecklenburg, Davidson, Wilson, Polk, Buncombe, Warren, Catawba, Henderson, Forsyth, Vance and Gaston. The value of the 1914 production amounted to $1,286,345.

In 1915 there were 30 operators in the following counties, given in the order of the importance of their productions: Surry, Rowan, Catawba, Rockingham, Wilson, Wake, Davidson, Henderson, Meck-

lenburg, Vance, Forsyth, Buncombe and Gaston. The value of the 1915 production amounted to $1,246,810.

In 1916 there were 39 operators in 13 counties, as follows, given in the order of the importance of their productions: Rowan, Surry, Stanly, Wilson, Vance, Rockingham, Henderson, Mecklenburg, Buncombe, Warren, Wake, Gaston and Alamance. It will be noted from the above order that Rowan takes first place in production over Surry for the first time. The value of the 1916 production amounted to $1,798,087.

In 1917 there were 33 producers from eleven counties, as follows, given in the order of the importance of their productions: Rowan, Surry, Wilson, Rockingham, Henderson, Wake, Vance, Mecklenburg, Buncombe, Cleveland and Gaston. The value of the 1917 production was $1,486,541, a slight decrease from the 1916 production, which was due to a falling off in the amount of granite quarried for use in concrete, and a slight reduction in the production of granite for building and monumental purposes. There has been a steady increase in the production of granite for making paving blocks.

In the following table there are given the use and value of granite produced from 1912 to 1917, inclusive:

USES OF GRANITE PRODUCED IN NORTH CAROLINA 1912—1917, INCLUSIVE.

Uses	1912	1913	1914	1915	1916	1917
Building and monumental purposes	$315,088	$408,931	$483,733	$417,721	$462,014	$ 406,073
Paving blocks	212,990	215,133	243,314	191,796	200,851	204,690
Curbing and flagging	135,016	92,240	87,286	89,222	124,845	160,663
Crushed stone for macadam, railroad ballast, etc.	105,879	162,632	158,645	243,987	401,893	270,788
Concrete	206,579	235,548	308,884	302,084	558,476	340,624
Other purposes	8,063	1,991	4,483	2,000	50,008	103,703
Totals	$983,615	1,116,475	1,286,345	1,246,810	1,798,087	1,486,541

The next table gives the value of granite produced from 1897 to 1917, inclusive; which shows very strikingly the remarkable growth of this industry in the State. The 1916 production is the greatest production of granite reported for any one year:

PRODUCTION OF GRANITE IN NORTH CAROLINA, 1897—1917.

Year	Value
1897	$ 59,236
1898	79,969
1899	225,544
1900	257,962
1901	264,906
1902	338,749
1903	334,357
1904	292,439
1905	564,425
1906	778,819
1907	906,476
1908	764,272
1909	743,376
1910	839,742
1911	772,685
1912	983,615
1913	1,116,475
1914	1,286,345
1915	1,246,810
1916	1,798,087
1917	1,486,541

Sandstone

The sandstones in North Carolina that have been quarried are from the triassic areas extending across the State in varying widths and covering portions of Granville, Durham, Orange, Wake, Chatham, Harnett, Lee, Moore, Montgomery and Anson counties. There is a similar belt of this sandstone which extends across a part of Rockingham, Stokes and Forsyth counties. The color of these sandstones varies somewhat throughout the belt, but it is usually reddish brown and sometimes a rather grayish brown.

In 1913 there was one producer of sandstone in Anson County. In 1914 there were two producers, one from Lee County and one from Mecklenburg. In 1915 there were three producers, one from Anson, one from Lee, and one from Gaston County. The 1915 production was valued at $27,544 and was used for road metal, railroad ballast and concrete. In 1916 there were only two producers, one from Anson and one from Gaston County. In 1917 there was only one producer, from Lee County. A large proportion of the output from this quarry was used for building purposes, and a small quantity for rubble.

The figures regarding the production of sandstone cannot be given except in combinations, because in most years the number of producers numbered less than three.

Rhyolite

There has recently been opened a quarry at Ball Mountain near Newsom, on the Winston-Salem Southbound Railway, of the trap rock rhyolite. The main line of the railroad runs at the foot of the mountain containing the quarry, and the machinery for manufacturing the stone is located on a siding paralleling the main line. The plant is located about the center of the quarry which faces the main line of the Southbound and the Yadkin River for some two thousand feet. It has an operating face 1,000 feet long and about 60 feet high. Four samples of this material were analyzed by Mr. J. H. Gibboney, chemist, to ascertain whether or not they contained plant food in sufficient amount to render them valuable for agricultural purposes. The following are the results of the tests made:

ROANOKE, VA., January 3, 1916.

"MR. W. H. LEWIS,
Superintendent Motive Power.

Dear Sir:

"The attached letters from Mr. Maher, of December 7th, and 15th, referring to 4 samples of stone from Ball Mountain Quarry, sent in by Mr. Fries, President of the Winston-Salem Southbound Railway, for examination, to ascertain whether or not they contained plant food in sufficient amount to render them valuable for agricultural purposes.

"Our results follow:

	No. 1	No. 2	No. 3	No. 4
	Per cent	*Per cent*	*Per cent*	*Per cent*
Silica	72.84	21.24	71.48	60.60
Iron oxide	4.47	4.66	4.47	8.79
Aluminum oxide	14.25	17.26	14.45	19.25
Calcium oxide	1.20	1.28	5.44	1.80
Magnesium oxide	.55	.61	.71	2.63
Sodium oxide	3.43	2.49	.60	1.73
Potassium oxide	3.07	1.90	.35	2.01
Loss on ignition	.14	.36	2.38	3.09
Undetermined	.05	.20	.12	.10

No. 1—Rhyolite from main face of quarry.
No. 2—Rhyolite from slide North of crushing plant.
No. 3—Altered rhyolite from North face.
No. 4—Basalt from North face.

"The only element of direct plant food present in these stones is the potassium, expressed by us as the oxide, but actually present in the stone mass as the silicate. Under certain conditions of treatment or soil reactions this material can be rendered available as a direct fertilizer; however, in our opinion, these particular stones are far too low in potassium to render them of value for agricultural purposes." (Signed) "J. H. GIBBONY,

"CHEMIST."

As there was only one producer of rhyolite in the State, the figures cannot be given here, but are included under the total stone production. The material was used for railroad ballast and concrete.

Marble and Other Forms of Limestone

Marble.

In the report on the mining industry for 1910 a detailed description of the marbles of the Nantahala area is given.

A brief visit was made in the summer of 1917 by Mr. John E. Smith, geologist for the Survey, to the marble quarries at Regal, Cherokee County, and Hewitts, Swain County. Mr. Smith made the following report:

"Regal, Cherokee County, North Carolina: Regal Marble Company, D. J. Deschler, Asheville, President; R. C. Boylan, Regal, Superintendent. A new quarry was opened three years ago. This rock is a part of the formation known as Murphy Marble, and is of Cambrian age. The bedding plains dip to the southeast steeply. It is quite solid and compact, and blocks 4 to 6 feet, up to a maximum of 4x13 feet, were seen on the yard. The cutting is done by four Sullivan and Ingersoll channelers and the large blocks of marble are moved by means of a crane.

"About 60 men are employed and nearly 1,000 cubic feet of marble is used daily. The product consists of two grades, known as Regal Blue and Confederate Gray; both of which are very high in quality. The equipment is complete, and consists of 7 cross cut gang saws; circular rubbing beds; turning lathe; circular saws, and other polishing and finishing implements driven by compressed air.

"The product consists chiefly of grave stones and ornamental work, and is sold in nearly every state in the Union, also in Canada and Mexico. Stones crated and labeled for shipment were seen in the shipping room. They go to the following states: Ohio, Michigan, Virginia, Indiana, Washington, Oklahoma, Iowa, Texas, Illinois, and to numerous points in nearby states. The company ships about 1 carload of finished product per week.

"Hewitts, Swain County, North Carolina: North Carolina Talc and Mining Company is operating the quarry and producing crushed stone for use in concrete work. The crusher is operated by water power—a 280-horsepower water wheel. This power also furnished electric lights in all of the company's buildings.

"A lime kiln having a capacity of 70 tons per week has been leased to the Interstate Lime Company, of Bristol, Virginia, and was operated about 3 months during 1917, closing in May. The limestone is of high quality, yielding about 97 per cent pure burned lime—a waste of only 3 per cent of the quarry material in burning. Much difficulty is experienced in obtaining cars in which to ship the materials produced at Hewitts."

Limestone.

The limestone figures given in this report refer also to the marl produced in the Coastal Plain and which is used largely for fertilizer

purposes. An investigation is now under way by the Geological Survey of the marls and limestones of the State which will give in detail information in regard to these various deposits.

In 1913 there were eight producers of limestone from the following counties, given in the order of the importance of their productions: Henderson, Madison, New Hanover, Swain, Cherokee, Columbus, Craven and Beaufort.

In 1914 there were eight producers from the following eight counties, given in the order of the importance of their productions: Henderson, Madison, New Hanover, Cherokee, Swain, Craven, Yadkin and Surry.

In 1915 there were eight producers from the following nine counties, given in the order of the importance of their productions: Henderson, Madison, Cherokee, Craven, New Hanover, Yadkin, Surry, Columbus and Swain.

In 1916 there were eight producers from the following eight counties, given in the order of the importance of their productions: Henderson, Madison, Jones, Craven, Swain, McDowell, Yadkin, and Cherokee.

In 1917 there were seven producers from the following seven counties, given in the order of the importance of their productions: Henderson, Madison, Jones, Columbus, McDowell, Swain and Craven. The 1917 production was used largely for agricultural purposes, the smaller amounts being used for concrete, road making, flux, tanneries, and building purposes.

Production

There is given in the table below the value of the production of marble and other forms of limestone from 1901 to 1917, inclusive:

Production of Marble and Other Forms of Limestone, 1901—1917.

Year	Value
1901	$ 8,357
1902	23,153
1903	25,365
1904	19,887
1905	29,015
1906	72,051
1907	46,338
1908	53,405
1909	106,931
1910	77,585
1911	81,651
1912	100,766
1913	140,364
1914	154,888
1915	164,344
1916	176,164
1917	233,950

Stone Producers During 1917

Granite

County	*Name*	*Address*
Buncombe	Ardmion Park Quarry Co.	Asheville, N. C.
	French Broad Quarry Co.	Asheville, N. C.
	Smith & Carver Development Co.	Asheville, N. C.
Cleveland	S. N. Lattimore	Shelby, N. C.
Gaston	Chas. M. Friday	Dallas, N. C.
	William Lockhart and J. P. Hoffman	Gastonia, N. C.
Henderson	W. B. Valentine, Lessee, Balfour Quarry Co.	Asheville, N. C.
	W. A. Smith	Hendersonville, N. C.
	Wright & Dixon	Hendersonville, N. C.
		(Mecklenburg Co.)
	Atlantic Bitulithic Co.	Charlotte, N. C.
	Charlotte Paving Co.	Charlotte, N. C.
Rockingham	Harris Granite Quarries Co.	Salisbury, N. C.
Rowan	Blue Pearl Granite Co.	Winston-Salem, N. C.
	J. T. Artz	Salisbury, N. C., R. 3
	Casper Barnes	Faith, N. C.
	Faith Granite Co.	Salisbury, N. C., R. 3
	Ganley Bros.	Salisbury, N. C., R. 3
	Byrd Bros.	Salisbury, N. C., R. 3
	Harris Granite Quarries	Salisbury, N. C.
	Hudson & Brown	Granite Quarry, N. C.
	Central Contracting Co., care Geo. R. Collins	Salisbury, N. C.
	John Parry	Granite Quarry, N. C.
	Robert Roberts	Granite Quarry, N. C.
	William Smith	Salisbury, N. C., R. 3
	B. C. Eagle	Salisbury, N. C., R. 3
	Salisbury Granite Corporation	Salisbury, N. C.
	J. T. Wyatt Granite Works	Salisbury, N. C., R. 3
Surry	North Carolina Granite Corp.	Mount Airy, N. C.
Vance	Raleigh Granite Quarry	Raleigh, N. C.
	Matthews Granite Quarries Co.	Knightsdale, N. C.
Wake	Raleigh Granite Co.	Raleigh, N. C.
Wilson	Harris Granite Quarries Co.	Salisbury, N. C.

Lime and Limestone

Avery	Clinchfield Lime Co.	Linville Falls, N. C.
Columbus	N. C. Department of Agriculture	Raleigh, N. C.
Craven	Lovit Hines	Kinston, N. C.
	Trent River Marl & Lime Co.	Pollocksville, N. C.
Henderson	Blue Ridge Lime Co.	Asheville and Fletcher, N. C.

County	*Name*	*Address*
Madison	The G. C. Buquo Lime Co.	Hot Springs, N. C.
Swain	N. C. Talc & Mining Co.	Hewitts, N. C.

MARBLE

	Regal Marble Co.	Regal, Cherokee County, N. C.

SANDSTONE

Anson	John T. Patrick	Wadesboro, N. C.
Lee	Capital Stone Co.	Sanford, N. C.
Gaston	Carolina Stone Co.	Columbus, Ga.
	Hardaway Contracting Co.	Bridgewater, N. C.

RHYOLITE

	Ball Mountain Stone Co.	Newsom, Madison County, N. C.

SAND AND GRAVEL

The sand and gravel marketed in North Carolina consists chiefly of building sand, gravel for railroad ballast, engine sand, paving sand, gravel for road making, and a small quantity of sand for grinding and polishing. So far, no glass sand has been put on the market from this State, though there are undoubtedly deposits of sand in North Carolina which could be used for this purpose.

"REQUIREMENTS OF GLASS SAND.

"The factors which determine the value of a deposit for making glass are chemical purity, physical character, quarrying conditions, and location with respect to transportation, cheap fuel, and market.

"Glass is a transparent impermeable substance formed by fusing sand, or silica, with fixed alkalies. It is made by melting the ingredients in a pot or tank, mixing the batch thoroughly, and allowing it to cool. It is molded into the desired form while molten. Sand is the principal constituent of all glass, comprising from 52 to 65 per cent of the mass of the original mixture. The qualities of the glass, such as lack of color, brilliance, transparency, and hardness, depend largely, therefore, on the quality of the sand.

"For the finest ware only the purest quartz (silica) sand can be employed because slight impurity, especially a small quantity of iron, impairs the brilliance, whiteness, and clearness. Thus, for the manufacture of glass for optical instruments, which is practically colorless, sand, or ground silica, should contain not more than 0.015 per cent of

ferric oxide. Plate and window glass are commonly pale green and absolute purity is not essential in the sand, but more than 0.2 per cent of ferric oxide is undesirable. Green and amber glass for rough structural work, as skylights, sidewalk lights, for bottles, jars, and insulators, are made from sand that has more impurity than is permissible in sand for plate glass and prescription ware.

"The suitability of a sand for making glass may be determined roughly by inspecting it for the following properties: The sand should consist almost entirely of quartz, or silica (most glass sands contain from 98 to more than 99 per cent of silica); it should be nearly white or easily washed white; the grains should be uniform in size, either angular or rounded, and preferably should not be larger than 20 mesh nor smaller than 80 mesh. Whiteness is not essential, however, in sand for ordinary window glass and cheap bottles and jars. Sand for window glass that has been dug at a New York locality for many years is pink or dark flesh-colored, and an Indiana sand used for making beer bottles is drab, because of a coating of clay on each of the colorless quartz grains.

"Most of the glass sand produced in this country is obtained by crushing soft, crumbly sandstones, but where power is very cheap, it is practicable to produce glass sand by crushing quartzite and vein quartz.

"Methods of quarrying and preparing the sand vary somewhat, but in general the quarry face is drilled and shot down with an explosive, and the coarse and fine material is delivered to the mill. If a special quality of sand is desired, selection may be made at the quarry by hand sorting. Large lumps, if very hard, are reduced by a jaw or rotary crusher, but in most places by a less powerful machine, such as a pug mill or muller or a crusher consisting of many heavy hammers revolving rapidly.

"Washing the crushed sand is done by two common methods. By one method the sand is carried first upward by a screw conveyor through a long, narrow inclined box against a descending stream of water and then downward in a narrow chute by a second stream of water. This process is repeated three or four times, after which the sand is spilled on a belt conveyor and carried to the draining piles. Another method of washing is by settling tanks. A stream of sand and water is discharged into a tank where the sand settles and impurities are drained off. Sand washed by this method may be left in the last tank to drain, or it may be carried to a draining pile. Sand carried away by the wash water in either process is caught in settling ponds or yards outside the mill and may be used for the various purposes to which a fine-grained silica sand is adapted.

"After draining for several hours, or days, the sand is dried, either rapidly in rotary cylindrical driers heated by gases from coke or other smokeless fuel, or slowly by settling through coils of steam pipes, and is then screened and put in stock bins. Glass sand is shipped in bulk in box cars, which are lined with paper to prevent leakage."

"Building Sand.

"Building sand is used for making plaster, mortar, and concrete. Wall and ceiling plaster, whether made of lime or gypsum, commonly contains a considerable quantity of sand, particularly in the base coat. Mortar used in laying brick, stone, and tile has a body of sand, and sand is a large constituent of much concrete. The reported production of building sand increases annually by reason of larger business and new names added to the list of producers. This sand probably is reported less completely than any other in the foregoing tables because its occurrence is common and widespread, and its use in small amounts by thousands of individuals is not reported to the Survey. The individual use often is only a wagon load or a few tons, but the aggregate of these of which the Survey gets no record must be hundreds of thousands of tons. In many small villages throughout the United States there is no regular dealer in sand and whoever needs a supply gets it from a local deposit. This may be a privately owned sand pit from which the owner may derive a few dollars a year, or it may be the dry bed of a stream from which sand is taken without charge."

"Grinding and Polishing Sand.

"Grinding and polishing sands are sharp, tough, hard sands free from clay or foreign material, and sized for use in sawing, cutting, and polishing stone, for grinding and etching glass, and for cleaning metal castings by means of a blast. Blast sand may be either round or angular grains."

Production

Sand and gravel produced in North Carolina as reported to the Geological Survey is from the following counties: Anson, Buncombe, Burke, Cleveland, Columbus, Cumberland, Gaston, Guilford, Halifax, Harnett, Henderson, Iredell, Mecklenburg, Montgomery, Moore, Northampton, Pender, Robeson, Scotland, Wake, Wayne, Wilkes and Wilson.

The following table gives the value of the production of sand and gravel in North Carolina from 1905 to 1917, inclusive, and the quantity produced from 1912 to 1917:

PRODUCTION OF SAND AND GRAVEL IN NORTH CAROLINA, 1905—1917, INCLUSIVE.

Year	Quantity Short Tons	Value
1905	....	$ 547
1906	....	9,191
1907	....	2,191
1908	....	2,070
1909	....	13,358
1910	....	13,406
1911	....	93,336
1912	161,198	38,487
1913	400,577	127,574
1914	492,092	72,989
1915	424,740	124,697
1916	554,381	150,209
1917	543,364	231,813

Producers

The following were producers of sand and gravel during the past five years:

Hardaway Contracting Co., Bridgewater, Burke County.
W. R. Bonsal & Co., Lilesville, Anson County.
Asheville Sand Co., Asheville, Buncombe County.
Cape Fear Gravel Co., Inc., Norfolk, Va. (Harnett County).
Riverside Sand Co., Charlotte, N. C. (Pit at Mt. Holly, Gaston Co.)
Atlantic Coast Line, Halifax County.
The Gale Sand Co., Green Pond, Scotland County.
Valentine & Co., Asheville, Buncombe County.
Balfour Quarry Co., Asheville, Buncombe County.
J. V. Wallace, North Wilkesboro, Wilkes County.

SAND LIME BRICK

As there has been no production of sand lime brick in North Carolina since 1912, the table of production is discontinued in this report.

CLAY AND CLAY PRODUCTS

With the exception of kaolin, all of which is shipped out of the State, there is but little clay which is mined and put on the market as a raw product. The bulk of the value of clay products given in the tables beyond represents the value of the products manufactured from the clay, and of those manufactured products, common brick represent by far the largest value. There has been a steady increase in the number and value of the brick produced and in the production of kaolin. With the large increase in the production of feldspar in west-

ern North Carolina and the tremendous demand for clay brought about by the war, there has been a growing interest in the development of clay deposits.

Production

There is given in the following tables the total production of clay products in North Carolina for the years 1912 to 1917, inclusive:

VALUE OF CLAY PRODUCTION IN NORTH CAROLINA FROM 1912—1917, INCLUSIVE

	1912		1913		1914	
	Quantity	Value	Quantity	Value	Quantity	Value
Common brick	193,058,000	$1,236,443	204,097,000	$1,354,062	183,648,000	$ 1,216,180
Front brick	1,131,000	10,085	1,772,000	15,757	1,310,000	14,964
Fire brick	324,000	4,430				
Earthenware		778		2,318		1,477
Stoneware		8,172		10,365		11,078
Miscellaneous ware				1,000		241
Sewer pipe, tile, etc.		205,745		230,904		216,850
	Tons		*Tons*		*Tons*	
Kaolin	14,950	109,717	16,332	139,629	17,168	164,334
Fire and pipe clays	20	104	20	15	605	303
Total values		1,605,474		1,754,050		1,625,427

	1915		1916		1917	
	Quantity	Value	Quantity	Value	Quantity	Value
Common brick	140,257,000	$ 862,391	193,264,000	$1,234,926	172,842,000	$ 1,346,211
Front brick	1,080,000	10,250	2,300,000	23,650	1,481,000	16,621
Fire brick	*				*	
Earthenware		2,504		1,290		1,269
Stoneware		8,190		7,805		5,756
Miscellaneous ware		700		765		450
Sewer pipe, tile, etc.		205,100		283,000		292,000
	Tons		*Tons*		*Tons*	
Kaolin	15,699	143,505	17,392	151,688	17,426	182,176
Fire and pipe clays	370	191	170	135		
Total values		1,232,831		1,703,259		1,844,483

*Included under front brick.

As stated above, these tables probably do not represent the total output of clay products throughout the State, for the reason that in a number of the counties there were a few thousand brick made for local purposes, regarding which it is extremely difficult or impossible to obtain statistics. This is especially true where the brick are not for sale but are for use by the manufacturer; and it may be a year or more before he manufactures any more.

The Geological Survey has in preparation a report on the clay deposits of the State which will be supplementary to the data contained in Bulletin 13 on the "Clay Deposits and Clay Industries in North Carolina."

Clay Tests

In 1917, the Survey began a series of tests in coöperation with the Bureau of Standards, U. S. Department of Commerce, at Pittsburgh, Pa. These tests were to be made on a number of clay samples, but the work was interrupted by war work. Tests were made, however, on four samples, as follows:

"167R. R. L. Steele, Rockingham, N. C.
180R. Cask of red clay from W. N. Garrett, Hot Springs, N. C.
193R. Marked No. 5. Jesse Bare, Box 49, R. 2, Crumpler, N. C.
216R. J. E. Coburn, Bryson, N. C.

"In order to make the tests more complete, chemical analyses were made and are as follows:

	167R	180R	193R	216R
Silica	69.29	55.44	49.61	48.08
Alumina	20.43	19.84	35.80	38.03
Iron oxide	1.67	8.54	1.57	.22
Calcium oxide	.32	.35	.20	.27
Magnesium oxide	.61	5.05	1.90	.04
Potassium oxide	2.67	7.55	.30	----------
Sodium oxide	.34	.60	.38	----------
Loss on ignition	4.91	3.00	11.32	13.69
Totals	100.28	100.37	100.14	100.33

"167R. R. L. Steele, Rockingham, N. C.

"This clay is a hard, short, non-plastic clay very difficult to make up into discs on account of its shortness and also very difficult to handle after drying. The material burns similar to kaolins but is of a poor color. When made up into a white ware body and glazed, it burns to a grey color that would make it of no commercial value for white ware. However it makes a pleasing shade of grey which might be of use in developing some artistic ware.

"The body used in this, as well as the other clays, is described below.

"180R. Cask of red clay from W. N. Garrett, Hot Springs, N. C.

"This clay is a hard homogeneous red clay of fine quality. On account of its hardness it had to be ground in a ball mill to reduce it to a slip. In trying to cast the ware it was necessary to add 25% of fire clay to

reduce the shrinkage. The pure clay required 38.9% of water in terms of the dry weight, for proper working. Drying shrinkage 12.78% in terms of the dry volume. A sample burned to 1180°C. had a volume shrinkage of 5.61% in terms of the dry volume. The color at different temperatures is as follows:

1000°C.	Salmon color, very porous.
1100°C.	Light red, porous.
1150°C.	Brick red, less porous.
1200°C.	Chocolate color, vitreous.
1250°C.	Black, overburned and out of shape.

"Burned at 1180° the absorption is 13%. The vitrification range appears to be much too narrow to permit the use of this clay for the manufacture of paving brick. The discs being sent you were burned at 1100°C.

"193R. Jesse Bare, Crumpler, N. C., R. F. D. 2

"This clay consisted of medium hard white lumps showing some brownish stains on the surface. The plasticity of this clay is very low and the discs cracked in drying. The clay required 38% of water. When fired to cone 14 in a kiln fired with natural gas, the color obtained was an excellent white. In drying the volume contraction was 15% in terms of the dry volume. The contraction in burning to cone 14 was 38% in terms of the dry volume.

"In the screen tests a residue of 48% was found on the 100-mesh sieve, 6% on the 150-mesh, 7% on the 200-mesh, 6% on the 300, and 41% passed the 300-mesh. In order to use this material it would have to be ground in a ball mill in order to develop sufficient plasticity for working purposes. This clay behaved very much like a holloysite. Its desirable color is the greatest point in its favor. See samples of the straight clay, also when made up in a body and glazed.

"216R. J. E. Coburn, Bryson City, N. C.

"This clay was also of a sandy nature and high in mica. Its color was white. It was found to be lacking in plasticity to a considerable extent and required ball mill grinding to make it suitable for use. The water of plasticity required was 35%. Its dry shrinkage was 17.5% in terms of the dry volume. Its firing shrinkage to cone 14 was 29% by volume in terms of the dry volume. In the sieve test it left a residue of 6% on the 100-mesh sieve, 1% on the 150, .3% on the 200, .1% on the 300, and 89% passed the last sieve. The principal point in connection with this clay is its beautiful white color which should make it attractive for pottery manufacture.

Manufacture of Ware

"The glazed ware is made up similar to a white ware body. In each case the body contained 28% of the clay under test. The rest of the mixture being made up of standard white ware materials. All ware was biscuited at cone 10. Part of the ware was glazed at cone 4 with white ware glaze and the rest glazed at cone 10 with a glaze corresponding to the formula for cone 4. There are some slight defects in the ware which could of course be overcome, if made in quantity and sorted."

Kaolin

There has been a steadily growing interest in the production of clays in the United States since the war began and the importation of English and German clays has been cut off. This is particularly true in regard to the finer grades of clay constituting china clays or kaolins. While the main source of the American kaolin is in the Southern States, no white ware pottery is made in the South, the three leading states in the manufacture of such products being Ohio, New Jersey, and West Virginia.

Several grades of pottery are made in the United States, varying from ordinary stoneware to the finest porcelains. In the lower grades of stoneware and Rockingham ware, ordinary clays are used, usually those found in the section where the potteries are located. The cream-colored ware is made from a mixture of low grade kaolin and ball clays. White granite, or ironstone china, is made of a purer grade of kaolin mixed with quartz and feldspar. A special variety of this ware is the sanitary pottery, such as wash bowls, bath tubs, etc. Another grade which is rapidly increasing in output is the electrical line, made up of fuse boxes, insulators, insulator tubes, etc. China or porcelain is made from the finest and purest materials. The thinner varieties are known as porcelain, though in American practice the term porcelain is more often applied to the semi-vitreous white granite ware. The essential components of white granite are kaolin, quartz and feldspar. To illustrate the mixture, the following proportions are used in two different plants:

	Parts	*Parts*
Kaolin	48.44	58.56
Quartz	45.36	30.36
Feldspar	5.20	11.08

The two great centers for the white ware pottery industry in this country are East Liverpool, Ohio, and adjoining portions of West Virginia, Pennsylvania, and Trenton, New Jersey. These plants all use a mixture of clays from Cornwall, England, South Carolina and Georgia.

In western North Carolina, in Mitchell, Yancey, Swain and Jackson counties, in the territory tributary to the Carolina, Clinchfield and Ohio Railroad, the Tallulah Falls and the Southern Railroads, are found the pegmatitic dikes cutting through the schist rocks of that area. In these dikes occur, in addition to the valuable mica deposits, the essential components of white ware and china pottery—the quartz, the feldspar, and kaolin. The prospecting and mining for mica through the past years has opened many kaolin deposits of value. Mica was regarded as the all-important mineral and the one from which quicker cash results could be realized. From these various mica mines and mica prospect pits and tunnels can be traced today the kaolin deposits over this area.

Kaolin is a secondary mineral in these dikes, and in all deposits of economic importance, has resulted from the decay and breaking down of feldspar. Mingled with this secondary kaolin occurs the quartz and mica minerals and the original pegmatite, as well as more or less partly altered feldspar. Near the surface of the dike the kaolin will be stained with the iron and other surface impurities. This change may extend to considerable depth. Some of the kaolin mines in this area have been worked to a depth of 150 feet and still show good kaolin.

The following extracts from a paper by G. P. Grimsley, in the *Manufacturer's Record* of June 18, 1914, will be of interest:

"In the preparation of the kaolin taken from these mines for the market, it is very important that they should be freed from these other minerals of the dike. Mica interferes with the plastic and tensile properties of the kaolin in pottery mixtures, and is also liable to color the ware by its iron content. Quartz being almost infusible lowers the shrinkage in drying and burning clays, and so is a most important part of the pottery mixture; but its variable quantity in the clays and in different portions of the kaolin would cause the potter so much trouble that it must be removed from the kaolin for market and then added as required by the potter. The removal of these impurities is the great problem in the preparation of kaolin for the market.

"A pure kaolin clay is white in color, with soapy feel, earthy fracture fusing or melting at about 2300°F., shows 2 to 5 per cent air shrinkage, with tensile strength of 8 to 25 pounds, and specific gravity of two and six-tenths.

"The kaolin as taken from the mines contains a large amount of very fine mica flakes and small quartz grains, which must be removed. In a number of analyses of the mine kaolins it was shown that there was present about 25 to 30 per cent kaolin, and the residue was impurities to

be removed. The present methods of refining this product yield about half of the kaolin, the other half being lost in the process of washing. In the mines of western North Carolina the kaolin is conveyed from the mine by a water flume to the washing plant. The kaolin is washed by passing it into a rectangular box, where it is stirred and thoroughly mixed in the water by revolving arms carrying wooden paddles. The clay is run from the washer to the sand wheel boxes. To the spokes of these wheels are attached iron cups or boxes open at the lower end with a sloping rim to the outer edge of the tank. The revolution of the wheel takes up from the bottom of the box the lumps of foreign material which at the upper position of the cups slides by the sloping rim to outside of box. The kaolin and fine particles of impurities pass in a flow of water to the sand trough, which is a couple of feet wide and 20 or more feet along, set nearly level in position. The slow movement of the solution in this level trough permits settling of most of the quartz sand and coarser mica.

"The kaolin bearing water passes from the sand trough into the mica troughs, arranged in a series, so that the solution passes in at one end and out at the other into the second mica trough, and back at the opposite end into the third, and so on. The flow through these troughs is produced by slightly tilting them. The troughs are one foot square and of varying length in different plants, 25 feet or more. From the mica troughs the kaolin water is passed over a series of stationary fine brass screens set sloping, in order to remove any fine flakes of mica left. From the screens the kaolin passes to concentrating tanks, where the kaolin settles to bottom and the excess water is drawn off. This settling is hastened by suspending alum in muslin bags in the tanks. The kaolin after settling is run into a circular agitator tank in which a vertical shaft with attached paddles rotates and thoroughly mixes the kaolin for the purpose of insuring a uniform product.

"From the agitator the kaolin is pumped under pressure into ordinary clay filter presses composed of a series of canvas bags in which the surplus water is forced out by the heavy pressure. The clay sheets removed from this filter press are carried to a steam drying shed and thoroughly dried, ready for shipment.

"By the above method of washing the kaolin from these mines, there is always danger of not removing all the fine mica. The presence of such fine mica flakes in the kaolin lowers its value. It is claimed in a number of large potteries that the foreign kaolins are more uniformly prepared and are always free from impurities. Whether this is true or not, there is a strong prejudice in favor of the imported kaolin. The

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outline of the present method of washing the kaolin would apply to nearly all kaolin mines in this country, and appears to be rather crude, both in appliances and methods. It has been the method for many years, with very little change. Possibly careful experimental work might disclose better and safer methods; certainly the loss of half of the available kaolin is not good engineering practice. If the American potters could always rely on the American product being uniform and free from all impurities, the demand for imported kaolins would decrease, and there would be a larger market for the home product. The quantity of kaolin available in this field is practically unlimited.

"Chemical analyses of the North Carolina kaolins compare most favorably with those of the standard foreign kaolins. Limoges and Dresden clays have long been famous for finest grades of china and porcelain in Europe. Cornwall, England, kaolin is imported into this country in quantity, and it is claimed by many potteries that its equal cannot be obtained in the United States. A study of these analyses shows that the iron percentage in the North Carolina kaolins is as low, and in some cases lower, than in the foreign product. They carry practically no lime or magnesia, both elements being present in the foreign kaolins. The ratio of aluminum to silica is much less in the German and French clays than in the North Carolina kaolins, but the Cornwall clay shows but little difference in this ratio to these Southern kaolins. The French and German clays contain high silica and rather low alumina. The Mitchell County kaolins are very close to theoretically pure kaolin, containing 46.3 per cent silica, 38.8 alumina and 14 per cent water. The chemical characters of the Southern kaolins are seen to be very similar to the standard foreign clays. The physical properties also seem to be similar. The Cornwall clay is plastic, and North Carolina kaolins are usually described as nonplastic. Certain kaolins near Franklin recently examined by the writer were found to be plastic, and other plastic kaolins may also be found in this area on more detailed examinations.

"The kaolin from the mine has a very different character and appearance to the washed kaolin ready for the market. In some cases it is decidedly sandy, due to the amount of fine quartz grains, and in mass is usually snow white. In some samples the mica is in large plates, half inch across, and in others very minute pieces. It is not very difficult to remove the quartz sand, but the minute mica flakes adhere to the kaolin particles, and require most careful washing to entirely remove them. The Mitchell County washed kaolin shows a slight cream tinge, and under a lens this is seen to be due to minute

lumps of yellowish clay. In these mines minerals of the uranium group are found, and this tinge may be due to minute particles of such minerals or their alterations. In the Snow Creek area the washed kaolin lacks this tinge and is snow white, but here the alteration has been less, for partially altered feldspar is common through the kaolin. In the kaolin in Macon County near Franklin the quartz and mica are in very minute flakes, and the yield of washed kaolin was higher than in other localities examined. The washed product was snow white, and also plastic, and could be molded into shapes, retaining them when dry. It is impossible to make any tonnage estimates in these areas, on account of small development, and the prospect openings are small and scattered, but there is an enormous tonnage available.

"With large deposits of plastic and nonplastic kaolins and other necessary ingredients of the china and porcelain mixtures in close proximity in these areas, it appears strange that none of the product is made in the South. Two reasons for this condition are, first, the use of cheap natural gas fuel in the Ohio and West Virginia districts; and, second, the fact that the expert potters are a clannish people, who have settled in these leading districts for many years, and are slow to change to new locations.

"There has been a very great development of Southern industries in the past decade, and it would seem as though the time was at hand for the successful development of white-ware pottery for manufacture in the South, not only to supply their own demands, but for shipment into other territory."

Several kaolin deposits were examined during the summer of 1917 by Mr. John E. Smith, who reports as follows:

"*Swain County:* Hugh J. Sloan's Mines on property of A. J. Cunningham 4 miles south of Bryson City. Sloan has lease on 130 acres, began operation July 20, 1916, and has worked continuously since, except in January and February. The plant consists of a one-story drying shed 125 feet long, at one end of which are the cylindrical section presses (Canton Pump Company, Ohio) operated by hand power. Sand troughs; 2 settling tanks, 36 x 10 x 5; a receiving tank; 2 rotary beaters; 2 paddle wheel sand dippers; pumps, etc. Power is supplied by 40-horsepower engine on a 60-horsepower boiler. Water is supplied by means of a triangular box flume ½ mile or more in length. The clay is transported down the mountain side from the pits by means of a clay flume 800 feet long. From the pit to the flume the kaolin is brought by dump cars on tramway 500 feet to ½ mile long. The dried pressed kaolin is hauled by teams 1 mile to a siding on the Alarka Valley Railway (Lumber road).

"The first vein worked was the one nearest the plant, 5 to 15 feet wide with numerous stringers, 50 feet deep and 80 feet or more in length. Direction N. 50° E. Some quartz and mica occurred in this clay and some graphic granite was found in the bottom of this pit which is now abandoned. The second pit (in distance from the plant but not yet connected by rail) has a vein of clay 5 to 8 feet wide, 35 feet deep and length exposed 25 feet. This vein contains mica crystals 1 to 2 inches wide and up to 5 in length but much less quartz than in No. 3, also spots of black powdery clay produced by the decay of some original mineral. The stripping above this clay is 3 to 5 feet thick. This vein has a strike N. 30° E. and probably occurs in the mica schist exposed nearby in the excavation from the tunnel. Very little clay has been removed from this pit. Pit No. 3 in distance from the plant ½ mile. This pit when visited was laid open but has not been worked to any great extent. Width 15 feet, depth proved by boring and exposure 40 feet, length proved by tunnels 70 feet. The clay bears a few cross seams of brown limonitic clay up to 1 foot in thickness. Small crystals of decayed mica ½ inch to 1 inch were seen near the margin and a small quantity of quartz is distributed throughout. No fresh feldspar was visible. This is a pretty white clay and gives promise of yielding well. The bearing of this dike is N. 87° E., only 3° from due E. The overburden exposed varies from 1 to 6 feet in thickness and the exposure is on a hillside where the dirt may be easily cast aside. The wall rock bordering the clay is entirely decayed but shows numerous thin streaks indicating that it was formerly a gneiss and decomposed in place. A tramway is being laid to this pit. Grading was completed, the ties placed, but the rails not yet distributed.

"*Jackson County:* At Dillsboro is a new plant on the Tuckaseegee River, 3½ miles from Sylva, owned by Charles J. Harris Clay Company. It was built in August, 1916, and began operating in March, 1917. This is known as the Rhoda plant. The mine is located about 7 miles up the river and is worked by means of a shaft, and the clay washed through the sand troughs into a flume 7 miles long leading to the screens and settling tanks at the plant. Two large filter presses, one square and one cylindrical, are installed on the second floor; the circular one contains gaskets (rubber band at margin of press to prevent loss in pressing). The building is 160 feet long and the upper floor, exclusive of the press room, is used as a drying shed and is 130 feet long. The dry clay is dropped through trap doors to the first floor and from there weighed and loaded into wagons. Four teams and teamsters are employed in hauling to Sylva and seven other men find work at the plant.

"There are three settling tanks, each 40 x 9 x 6 feet outside measurement, and a slip tank of the same dimensions between this three and the drying shed from which it is pumped to the filter presses. The product of refined clay is about one carload per week. It is shipped to Trenton, N. J., and to East Liverpool, Ohio.

"The Harris Company are also working several other kaolin pits in Jackson County."

Production

There is given in the table below the production of koalin in North Carolina for the years 1900–1917, inclusive:

PRODUCTION OF KAOLIN IN NORTH CAROLINA FROM 1900—1917, INCLUSIVE.

Year	Amount	Value
	Tons	
1900	7,000	$ 62,440
1901	15,575	119,172
1902	13,322	108,105
1903	8,605	76,000
1904	9,110	76,670
1905	10,988	85,622
1906	10,803	90,036
1907	11,035	85,505
1908	10,532	85,300
1909*	12,097	99,174
1910*	14,080	119,040
1911	14,903	130,610
1912	14,950	109,717
1913	16,332	139,629
1914	17,168	164,334
1915	15,699	143,505
1916	17,392	151,688
1917*	17,426	182,176

*Contains small amount of fire clay, stoneware clay and brick clay.

Producers

The following were producers of kaolin during 1917:

J. A. Smith, Bessemer City, Gaston County.
The Hand Clay Co., Canton, Haywood County.
Harris Clay Co., Dillsboro, Jackson County.
Intermont China Clay Co., Bandana, Mitchell County.

POTTERY CLAY

Although North Carolina has a comparatively large number of active potteries reporting a production of pottery products, yet the industry is of little importance as compared with the pottery industry of the

country at large. The *Charlotte Observer* of October 16, 1916, contained the following editorial:

"THE POTTERY BUSINESS

"An item copied in The Observer about a wagon load of crocks, jars and jugs arriving at Mocksville from a pottery in Catawba County, reminds the *Wilmington Star* of the time when the pottery flourished in this section of North Carolina. It is still an industry of considerable consequence. 'Mecklenburg,' says *The Star*, 'used to have two jug factories, strictly rural industries,' and it thinks there is no reason why the ceramic industry should not flourish in western North Carolina, for the geologists state that the several varieties of clays to be had in great abundance 'are among the finest to be found in America.' The pottery industry at one time was of commercial importance to Lincoln, Catawba, and adjoining counties and had attained extensive proportions at the outbreak of the Civil War. The old Potter's road that runs by Charlotte to the north and east, secured its name by reason of the fact that it was the direct route from the potteries in these counties to Charleston, which was the pottery market for this section of the South. This industry might still be revived on a profitable basis, but the world has probably picked up too fast a pace for it, or maybe the pottery heirs and assigns are too lazy to keep the wheels going."

Production

In the table below there is given the value of the pottery products in North Carolina, by counties, for the years 1913-1917, inclusive:

VALUE OF THE POTTERY PRODUCTS OF NORTH CAROLINA, BY COUNTIES, FROM 1913—1917, INCLUSIVE.

County	1913				1914			
	Earthenware	Stoneware	Miscellaneous	Total	Earthenware	Stoneware	Miscellaneous	Total
Alamance	$ 160	$ 240	$......	$ 400	$ 160	$ 240	$......	$ 400
Buncombe	1,150	2,200	1,000	4,350	50	2,500	241	2,791
Catawba	125	2,940	....	3,065	398	2,413	....	2,811
Lincoln	58	1,645	....	1,703	101	1,575	....	1,676
Moore	440	800	....	1,240	400	800	....	1,200
Randolph	340	1,192	....	1,532	318	2,400	....	2,718
Union	....	400	....	400	....	350	....	350
Wilkes	45	948	....	993	50	800	....	850
Totals	2,318	10,365	1,000	13,683	1,477	11,078	241	12,796

County	1915				1916				1917			
	Earthenware	Stoneware	Miscellaneous	Total	Earthenware	Stoneware	Miscellaneous	Total	Earthenware	Stoneware	Miscellaneous	Total
Alamance	$150	$150	$....	$300	$150	$150	$....	$300	$200	$300	$....	$ 500
Buncombe	850	1,100	700	2,650	265	1,830	765	2,860	700	1,100	450	2,250
Catawba	148	2,219	......	2,367	550	2,416	......	2,966	159	1,656	......	1,815
Lincoln	380	1,300	......	1,680	200	1,560	......	1,760	100	960	......	1,060
Moore	300	500	......	800	......	300	......	300	50	400	......	450
Randolph	635	1,365	......	2,000	......	......	......	......	......	......	......	......
Union	......	381	......	381	......	374	......	374	......	......	......	......
Wilkes	41	1,175	......	1,216	125	1,175	......	1,300	60	1,340	......	1,400
Totals	2,504	8,190	700	11,394	1,290	7,805	765	9,860	1,269	5,756	450	7,475

In the following table there is given the total value of the pottery products in North Carolina, by counties, for the years 1913-1917, inclusive:

PRODUCTION OF POTTERY IN NORTH CAROLINA, 1900—1917.

Year	Value
1900	$ 18,863
1901	22,495
1902	14,512
1903	14,312
1904	13,900
1905	13,319
1906	11,770
1907	10,222
1908	13,362
1909	18,709
1910	14,990
1911	8,556
1912	8,950
1913	13,683
1914	12,796
1915	11,394
1916	9,860
1917	7,475

FIRE CLAY AND PIPE CLAY

There is included under this head fire and pipe clay and shales and products manufactured from them such as fire brick, sewer pipe, drain tile, fancy tile, flue linings, terra-cotta, etc. The portion of the productions of these clays and shales is from Guilford County.

Production

There is given in the table below the productions of fire clay, shale and pipe clay and the products manufactured from them for the years 1901–1917, inclusive:

PRODUCTION OF FIRE CLAY AND CLAY PRODUCTS IN NORTH CAROLINA, 1901—1917.

Year	Fire Brick		Sewer Pipe, Tile, etc.	Crude Clay	
	Quantity	Value		Tons	Value
1901	55,000	$ 550	$ 55,745		$ 100
1902		1,203	72,618		215
1903	407,500	5,250	100,989	231	875
1904	163,000	2,700	110,800	80	700
1905	681,000	8,333	102,445	57	494
1906	401,000	7,180	113,900	19	185
1907	194,000	3,490	142,000	903	986
1908	700,000	7,560	19,335	2,298	349
1909			133,925		753
1910			163,555	80	40
1911	130,000	1,800	185,804	81	56
1912	324,000	4,430	205,745	20	104
1913			230,904	20	15
1914			216,850	605	303
1915	*	†	205,100	370	191
1916			283,000	170	135
1917	*		292,000	†	†

*Small quantity included with Front Brick in table on page 140. †Included under Kaolin, page 140.

It is interesting to note the steady increase in the value of the production of this type of clay products, particularly of the sewer pipe, tile, etc.

Producers

Those producing these clays and manufactured products during 1917 were as follows:

Joseph H. Vincent, Snow Camp, Alamance County.
Reems Creek Pottery Works, Brankton, Buncombe County.
W. M. Penland, Candler, Buncombe County.
Omar Khoyyam Pottery, Candler, Buncombe County.
W. H. Blackburn, Newton, Catawba County.
Reinhardt Bros., Lincolnton, Lincoln County.
Robt. D. Ritchey, Prop., Henry, Catawba County.
Wade D. C. Johnson, Henry, R.F.D. 2, Catawba County.
J. A. Propst & Son, Henry, R.F.D. 2, Catawba County.
R. P. Speagle, Newton, R.F.D. 1, Catawba County.
Royal M. Stallings, Henry, R.F.D. 2, Catawba County.

S. L. Hartsoe, Henry, Catawba County.
M. L. Leonard, Henry, R.F.D. 1, Catawba County.
Manager, Home Pottery, Steeds, Moore County.
W. T. Brackett, Henry, R.F.D. 2, Catawba County.
John W. Teague, Steeds, Moore County.
Wilkesboro Pottery Works, Wilkesboro, Wilkes County.

BRICK CLAY

There has been considerable advance in the method of manufacture of common brick in North Carolina, and the following description of a plant which has recently been installed will be of interest.

"$100,000 Brick Plant Begins Operation in North Carolina*

BY FRED A. OLDS

"Exceptional construction and other features are said to be embodied in the up-to-date brickmaking plant just put in operation at Brickhaven, Chatham County, North Carolina, by the Cherokee Brick Company of Raleigh. The plant, which is to have a daily output of 100,000 brick and employ 50 men, is located in the valley of the Cape Fear River, where there is a large deposit of clay of a high type. Electric power, furnished by the Carolina Power & Light Company over a line built to Brickhaven for supplying the 450-horsepower required, is used throughout. A. R. D. Johnson is president; E. C. Hillyer, vice-president, and C. A. Johnson is the secretary and treasurer, all of Raleigh.

"As this plant was under construction when the war broke out and during the time the pessimists of the cotton country were predicting financial ruin for the South because of low-priced cotton, the determination of those backing the enterprise to bring it to a successful completion is an object-lesson illustrating what can be accomplished under such conditions by men who have faith in their ability and in their country.

"Modern methods of handling are utilized from the time the clay is dug by a steam shovel, loaded on steel dump cars and hauled by a locomotive to the point where it is prepared, tempered and made into the finished product. Details of the handling of the material were worked out and perfected by Vice-President Hillyer, who also did the necessary general engineering work and superintended the construction of the plant. The problem of handling the large production, both into

**Manufacturer's Record*, November 25, 1915, page 46.

and out of the kilns, has been minimized to the last degree by the use of mechanical devices and electric power to eliminate work usually done by hand.

"From the point where the clay is prepared and made into bricks the latter are taken on steel cars and carried to the dryer. After drying they are conveyed by a traveling crane to the kilns, where the "setters" take them from the dryer cars, placed on turntable platforms and set the brick. The crane service successfully eliminates "tossing," thereby facilitating the setting, besides reducing this part of the manufacturing cost.

"Unusually high and wide kilns have been built, higher than ever attempted where the brick are tossed. This method of construction is said to reduce the proportion of salmon brick and effect the greatest possible economy in fuel. Steel-trussed, metal-covered, permanent roofs cover all the kilns.

"From the kilns a traveling crane takes the burned brick, 700 at a time, and loads them into gondola cars. At least four-fifths of the breakage due to the usual method of handling by means of wheelbarrows is said to be eliminated. The crane service for shipping also makes possible the shipment of brick at a rate not attainable by other methods of loading cars. The company loads and ships out of one kiln a car of brick in an hour, and is equipped for carrying on this part of the work at night as well as by day.

"The handling of coal both for drying and burning the brick is done with the greatest dispatch and at the lowest cost, due to the economy and efficiency of the method designed and carried out by Mr. Hillyer."

Production

The production of the various types of brick that were manufactured from brick clay, such as common brick, pressed brick, fancy brick, etc., is dependent largely upon the demand for builders' materials. There has been a steady increase in the number and value of common brick manufactured during the past 4 years, despite war conditions, which have tended to cut down construction work. In 1913 there were 204,097,000 common brick manufactured, valued at $1,354,062. This was an increase over the 1912 production of 11,039,000 brick and of $117,619 in value. The 1913 production was the largest production yet made in the State, as will be seen from the table given below. There was a decrease in the production of common brick during 1914 and

1915, with a slight picking up in 1916 and another slight decrease in 1917. The average value of common brick per thousand in 1913 was $6.63 as compared with $6.40 in 1912. In 1914 the average value per thousand was $6.62; in 1915 the average value per thousand dropped to $6.14; in 1916, it advanced to $6.38; and in 1917, the price advanced to $7.84 per thousand.

The table below gives the number and value of common brick manufactured in North Carolina, by counties, for the years 1913 to 1917, inclusive. Where there were less than three producers in a county, they are combined in groups.

PRODUCTION OF COMMON BRICK IN NORTH CAROLINA DURING 1913—1917, BY COUNTIES.

County	1913		1914		1915		1916		1917	
	Number Common Brick	Value	Number Common Brick	Value	Number Common Brick	Value	Number Common Brick	Value	Number Common Brick	Value
Alamance	4,950,000	$ 31,275	3,650,000	$ 22,800	2,250,000	$ 12,000	4,340,000	$ 24,540	4,040,000	$ 29,680
Anson					----	----	----	----	----	----
Beaufort	5,237,000	39,276	4,090,000	28,570	3,562,000	21,129	1,714,000	12,255	750,000	6,000
Bertie								----	----	----
Buncombe	6,300,000	37,800	6,200,000	38,450	5,256,000	34,308	4,950,000	31,250	2,150,000	16,225
Burke										
Cabarrus	2,300,000	16,250	2,100,000	12,000	----	----	----	----	----	----
Caldwell	2,140,000	12,540	1,807,000	10,581	1,143,000	7,141	712,000	4,084	25,902,000	195,348
Camden	1,365,000	8,030	1,521,000	9,287	495,000	3,090				
Catawba										
Chatham	2,300,000	14,500	2,500,000	16,750	7,200,000	40,300	25,701,000	150,782		
Chowan										
Cleveland	2,950,000	18,700	1,808,000	11,470	1,160,000	8,210	1,798,000	11,738	2,721,000	19,048
Columbus										
Craven	10,154,000	64,910	12,866,000	78,161	9,421,000	52,527	11,908,000	71,124	14,223,000	106,818
Cumberland	3,880,000	24,500					3,600,000	22,600		
Davidson	472,000	3,317	262,000	1,865	2,075,000	12,600	500,000	3,600	325,000	2,547
Davie					----	----	----	----	----	----
Duplin					----	----	----	----	----	----
Durham	5,300,000	39,350	5,176,000	37,331	4,811,000	34,177	3,668,000	27,274	2,176,000	19,232
Edgecombe	700,000	4,800	525,000	3,050	550,000	3,900	300,000	2,000	----	----
Forsyth	6,890,000	48,846	7,600,000	49,690	4,150,000	25,800	5,206,000	33,800	3,775,000	28,600
Gaston	5,096,000	36,368	7,400,000	54,240	8,450,000	50,700	12,400,000	74,400	10,194,000	74,960
Granville	873,000	7,572	5,340,000	37,263	4,868,000	36,813	5,024,000	36,755	----	----
Guilford	8,084,000	51,222							2,337,000	22,806
Halifax	6,950,000	51,050	6,800,000	49,300	4,753,000	29,995	6,500,000	44,050	4,650,000	34,150
Harnett	8,700,000	56,200	6,937,000	41,846	----	----	12,911,000	77,267	----	----
Henderson					6,288,000	36,050			10,813,000	73,366
Hoke							----	----	----	----
Iredell	7,917,000	58,347	8,219,000	52,668	6,357,000	40,837	8,100,000	54,550	8,693,000	70,870
Johnston										

Lee	----------	----------	2,075,000	15,675	1,470,000	9,030	----------	----------	----------	----------
Lenoir	1,566,000	7,600								
Lincoln			----------	----------	----------	----------	2,800,000	18,800	2,875,000	22,475
Madison	1,575,000	11,270	1,960,000	12,960	----------	----------	1,196,000	9,629		
Martin							8,895,000	57,899	800,000	6,400
Mecklenburg	8,700,000	56,500	6,875,000	42,150	6,827,000	40,957			8,790,000	68,804
Montgomery	1,430,000	9,440	----------	----------			344,000	2,108		
Moore	3,900,000	27,000	5,729,000	40,100	5,250,000	35,400	5,300,000	41,800	5,890,000	43,700
Nash										
New Hanover							3,000,000	18,000		
Orange	5,615,000	41,625	5,500,000	38,500	5,000,000	37,000	----------	----------	7,948,000	62,658
Pamlico			----------	----------	----------	----------	----------	----------	----------	----------
Pasquotank	----------	----------	2,050,000	13,050	2,230,000	13,680	1,800,000	10,800	1,800,000	14,300
Pender	2,100,000	11,900								
Perquimans	6,310,000	47,180	8,275,000	57,550	----------	----------	----------	----------	----------	----------
Pitt					6,870,000	40,615	4,500,000	29,100	5,710,000	49,600
Randolph	4,850,000	29,475	1,925,000	12,188	2,650,000	16,725	3,300,000	20,625	2,546,000	17,500
Richmond	----------	----------	1,370,000	9,250	----------	----------	----------	----------	----------	----------
Robeson	3,555,000	23,959			1,400,000	8,800	2,465,000	15,250	1,483,000	11,933
Rockingham			2,160,000	14,630	1,400,000	8,800	1,100,000	7,600	1,300,000	12,600
Rowan	6,167,000	38,550	6,600,000	41,200	5,471,000	30,200	5,621,000	35,600	5,000,000	38,081
Rutherford	970,000	7,550	400,000	2,850	602,000	4,700	----------	----------	800,000	6,800
Sampson							1,000,000	7,000		
Stanly	12,113,000	74,420	5,125,000	31,275	4,100,000	22,300	4,800,000	30,600	10,500,000	81,000
Stokes			6,921,000	44,640	6,085,000	35,002	5,000,000	30,000		
Surry	680,000	3,980	2,350,000	15,950	700,000	5,350	1,395,000	11,627	355,000	2,655
Union	1,600,000	10,400	870,000	5,475	----------	----------	----------	----------	----------	----------
Vance	----------	----------			----------	----------	----------	----------	----------	----------
Wake	11,800,000	63,000	7,950,000	45,900	2,400,000	14,050	5,897,000	35,119	3,156,000	25,600
Washington	----------	----------	----------	----------	578,000	4,733	1,200,000	7,400	1,240,000	8,780
Watauga	a----------	----------	----------	----------						
Wayne	33,300,000	230,000	25,682,000	177,775	11,247,000	68,000	21,300,000	142,000	17,000,000	149,175
Wilkes	2,008,000	10,060	b----------	----------						
Wilson	3,300,000	25,300	4,000,000	34,500	3,188,000	17,472	3,019,000	21,900	2,900,000	24,500
Yadkin			1,030,000	5,240					----------	----------
Totals	204,097,000	$1,354,062	183,648,000	$1,216,180	140,257,000	$ 862,391	193,264,000	$1,234,926	172,842,000	$ 1,346,211

aIncluded under Wilkes. bIncluded under Yadkin.

Producers of Brick and Tile in North Carolina During 1917

County	*Name*	*Address*
Alamance	W. C. Michael	Elon College, N. C.
	Parks & Jeffreys	Graham, N. C.
	Trolinger & Montgomery	Mebane, N. C.
	Maben L. Stuart	Sylvester, N. C.
Beaufort	Pamlico Brick & Tile Co.	Washington, N. C.
Buncombe	Geo. C. Shehan Brick Co.	Asheville, N. C.
Burke	Morganton Brick Co.	Morganton, N. C.
Caldwell	Powell Bros. Brick Co.	Lenoir, N. C.
Catawba	L. W. Poovey Brick Co.	Hickory, N. C.
	E. M. Deal	Newton, N. C.
Chatham	B. N. Welch	Bear Creek, N. C., R. 1
	Johnson & Johnson Co.	Brickhaven, N. C.
	C. N. Bray & Bro.	Siler City, N. C.
Chowan	Edenton Brick Works	Edenton, N. C.
	Tuttle & Bell	Edenton, N. C.
Cleveland	J. A. Falls	Kings Mountain, N. C.
Columbus	Williamston & Nance	Cerro Gordo, N. C.
	Oscar High	Whiteville, N. C.
Craven	Clark Brick & Tile Co.	Clark, N. C.
	Geo. T. Eubanks	Clark, N. C.
	Carolina Brick Co.	Kinston, N. C.
	New Bern Brick Co.	New Bern, N. C.
	H. M. Wethington	Vanceboro, N. C.
	Peoples Brick Co.	New Bern, N. C.
Cumberland	E. A. Poe Brick Co., Inc.	Fayetteville, N. C.
Davidson	L. A. Smith	Denton, N. C.
	Ragan Brick Co.	Thomasville, N. C.
Durham	Cheek & Belvin	Durham, N. C.
	R. Fitzgerald	Durham, N. C.
Forsyth	Adrian L. Dean	Kernersville, N. C.
	B. X. & R. T. Linville	Kernersville, N. C., R. 4
	R. F. Byerly & Co.	Winston-Salem, N. C.
	R. W. Hedgecock	Winston-Salem, N. C.
	R. L. Whitfield & Co.	Winston-Salem, N. C.
Gaston	Kendrick Brick & Tile Co.	Mt. Holly, N. C.
	A. B. Lewis	Belmont, N. C.
	Gaston Brick Co.	Charlotte, N. C.
	Mo-Ho Brick Co.	Mt. Holly, N. C.
	Harrison & Ellington	Lowell, N. C.
Guilford	Cunningham Brick Co.	Greensboro, N. C.
	J. G. Williams	Greensboro, N. C.
	Pomona Terra-Cotta Co.	Pomona, N. C.
Halifax	J. W. Madry	Scotland Neck, N. C.
	Chokoyotte Brick Co.	Weldon, N. C.

County	Name	Address
Halifax (Cont.)	L. N. Gant	Weldon, N. C.
	Weldon Brick & Land Improvement Co.	Weldon, N. C.
Henderson	D. S. Hildebrand	Brickton, N. C.
	Asheville Brick & Tile Co.	Fletcher, N. C.
	J. C. Sherrill	Hendersonville, N. C.
Iredell	Statesville Brick Co.	Statesville, N. C.
Johnston	Selma Brick Co.	Selma, N. C.
	C. W. Beasley	Smithfield, N. C.
Lee	Goldston Brick Co.	Cumnock, N. C.
	Thomas Bros. Brick Co.	Jonesboro, N. C.
Lenoir	Moseley Brick & Shingle Co.	Kinston, N. C.
Madison	John R. Anderson	Mars Hill, N. C.
Martin	Martin County Brick & Tile Co.	Williamston, N. C.
Mecklenburg	Queen City Brick Co.	Charlotte, N. C.
	Riverside Brick Co.	Charlotte, N. C.
Montgomery	L. L. Richardson	Star, N. C.
Moore	W. M. Kivett	Carthage, N. C.
Nash	Tar River Brick Co.	Rocky Mount, N. C.
New Hanover	Roger Moore's Sons & Co.	Wilmington, N. C.
Orange	J. T. Fowler	Hillsboro, N. C.
Pasquotank	Elizabeth City Brick Co.	Elizabeth City, N. C.
Pender	J. T. Harrell	Burgaw, N. C.
Pitt	W. J. Gardner & Son	Bethel, N. C.
	Farmville Brick Co.	Farmville, N. C.
	W. H. Dail, Jr.	Greenville, N. C.
Randolph	W. L. Foust	Ashboro, N. C.
	Elmer Rich	Ashboro, N. C.
	Glenola Brick Co.	High Point, N. C.
	Liberty Brick Co.	Liberty, N. C.
	B. W. Walden	Randleman, N. C.
Robeson	C. M. Reaves	Proctorville, N. C.
	Bracey Bros. Brick Co.	Rowland, N. C.
Rockingham	J. M. Hopper	Leaksville, N. C.
	James A. Foust & Son	Madison, N. C.
	Jennings & Ware	Reidsville, N. C.
Rowan	Nessman-Kennedy Brick & Lumber Co.	Salisbury, N. C.
	Yadkin River Brick Yard	Salisbury, N. C.
	Isenhour Brick Co.	Salisbury, N. C.
Rutherford	Martin D. Hill	Rutherfordton, N. C.
Sampson	J. B. Bryan	Roseboro, N. C.
Stokes	Shale Paving Brick and Fire Roofing Co.	Pine Hall, N. C.
	Hedgecock Brick Co.	Walnut Cove, N. C.

County	*Name*	*Address*
Surry	John W. Gardner	Mount Airy, N. C., R. 3
	J. L. Banner	Mount, Airy, N. C.
	C. C. Midkiff	Mount Airy, N. C., R. 2
Wake	Holly Springs Land and Improvement Co.	Holly Springs, N. C.
	Raleigh Brick Co.	Raleigh, N. C.
	Johnson & Johnson Co.	Raleigh, N. C.
Washington	Plymouth Brick Co.	Plymouth, N. C.
Watauga	Boone Brick Co.	Boone, N. C.
Wayne	Borden Brick & Tile Co.	Goldsboro, N. C.
	Wayne Red Brick Co.	Goldsboro, N. C.
	H. Weil & Bros.	Goldsboro, N. C.
Wilkes	Houck & Henry	North Wilkesboro, N. C.
Wilson	Wilson Clark Brick Co.	Wilson, N. C.

SUMMARY

There is given in the table below the value of the mineral production of each county in North Carolina for the years 1912–17, inclusive:

VALUE OF MINERAL PRODUCTION IN NORTH CAROLINA, 1912—1917, INCLUDING CLAY PRODUCTS

County	Total Value of Mineral Production					
	1912	1913	1914	1915	1916	1917
Alamance	$ 28,400	$ 26,075	$ 21,700	$ 12,300	$ 24,856	$ 30,180
Alexander	624	380	528	269	226	103
Alleghany	300	500	875			100
Anson	7,104	110,572	41,516	10,110	113,399	92,906
Ashe	5,300	3,500	1,500	2,604	3,460	28,962
Avery	186,264	238,450	125,687	182,904	324,568	447,717
Beaufort	16,048	29,500	18,070	12,500	6,000	6,000
Bertie (*a*)	10,527	12,276	10,500	8,629	7,255	
Bladen						
Brunswick						
Buncombe	75,114	71,122	40,303	28,275	37,366	47,821
Burke	14,104	17,233	15,246	9,649	11,413	51,809
Cabarrus	23,735	16,798	12,022	282	462	750
Caldwell	16,386	12,752	11,184	7,292	4,184	3,125
Camden (*b*)		1,500	2,287	1,715		
Carteret						
Caswell		50	1,000	444	375	300
Catawba	12,510	9,846	22,209	144,574	5,250	13,315
Chatham	6,250	4,125	3,190	26,380	143,566	164,223
Cherokee	33,134	36,663	62,669	69,937	55,064	144,434
Chowan (*b*)	8,400	10,500	13,750	14,000	15,407	16,848
Clay	1,200	6,000				1,200
Cleveland	15,429	18,003	11,330	12,904	9,103	7,516
Columbus	7,500	11,600	3,000	5,700	4,250	25,656
Craven	59,150	68,760	64,011	62,127	78,624	79,986
Cumberland	33,316	27,500	29,886	17,940	23,600	26,905
Currituck						
Dare						
Davidson	34,271	22,998	34,500	38,000	3,600	24,569
Davie	1,400	1,200				
Duplin (*c*)	80	197	165			
Durham	41,040	41,460	39,896	35,277	28,074	21,608
Edgecombe	18,410	4,800	3,050	3,900	2,000	
Forsyth	45,893	48,930	55,490	27,150	33,800	28,600
Franklin	1,228				200	1,100
Gaston	27,756	40,590	61,335	124,505	137,715	345,420
Gates						
Graham						
Granville	14,869	18,672	12,312	20,129	11,802	5,827
Greene						
Guilford	273,150	281,542	249,263	240,291	314,430	315,301
Halifax	58,933	53,601	54,756	30,320	44,050	39,322
Harnett	1,500	26,685	3,660	20,220	14,500	13,776
Haywood	5,912	6,541	5,080	9,200	38,250	59,840
Henderson	98,417	82,202	85,100	119,584	195,345	226,397
Hertford						
Hoke		1,200	1,600	300		
Hyde						

*a*Included with Beaufort County. *b*Included with Caldwell County. *c*Included with Durham County.

VALUE OF MINERAL PRODUCTION IN NORTH CAROLINA, 1912-1917, INCLUDING CLAY PRODUCTS—Continued.

County	Total Value of Mineral Production					
	1912	1913	1914	1915	1916	1917
Iredell	$ 24,466	$ 29,834	$ 35,764	$ 27,157	$ 36,928	$ 49,945
Jackson	63,413	72,717	71,989	63,096	52,686	95,236
Johnston	28,550	40,000	32,400	24,800	34,200	38,000
Jones	15,100				9,000	18,000
Lee	2,950		2,175	1,730	6,200	16,183
Lenoir	6,000	7,000	15,000	8,400	12,600	16,000
Lincoln	3,295	2,303	1,676	3,855	1,760	1,060
McDowell	615	1,019	2,426	500	900	1,800
Macon	91,300	82,748	73,190	5,355	68,543	121,643
Madison	12,400	45,030	39,676	33,885	70,458	63,640
Martin	8,125	5,620	7,030	3,620	2,800	4,000
Mecklenburg	105,817	127,486	98,200	61,069	98,526	112,822
Mitchell	238,192	226,220	214,532	315,647	186,839	262,030
Montgomery	162,501	126,198	88,553	95,233	6,541	3,700
Moore	41,901	31,428	14,410	56,395	32,031	24,001
Nash	21,000	21,000	35,000	28,000	40,000	40,500
New Hanover	40,839	38,763	42,763	25,888	18,000	25,658
Northampton						51,648
Onslow	350					
Orange	10,500	8,625	10,500	17,500		37,000
Pamlico						
Pasquotank	7,600	9,000	9,750	10,400	9,600	8,800
Pender	18,000	11,900	4,912	3,430	1,200	5,500
Perquimans	4,000	2,100	2,000			
Person			718	500		
Pitt	36,800	45,080	55,550	40,615	29,100	49,600
Polk	10,338	26,041	18,115			
Randolph	15,320	33,501	14,957	18,725	20,625	18,300
Richmond			700			
Robeson	17,634	17,050	8,550	8,810	15,250	11,933
Rockingham	51,839	63,323	75,437	98,910	93,420	97,890
Rowan	382,571	411,608	438,757	308,099	540,643	583,639
Rutherford	5,315	2,984	3,797	7,707	7,022	9,105
Sampson	6,300	5,200	2,150	3,700	7,000	3,600
Scotland					5,575	6,660
Stanly	19,640	24,000	152,076	26,480	339,792	40,810
Stokes	42,890	52,745	47,427	37,022	31,566	46,169
Surry	422,227	481,917	526,907	605,201	506,873	513,968
Swain	46,318	35,689	29,140	23,001	12,955	17,950
Transylvania	2,800	2,300	1,100	1,060	2,300	3,100
Tyrrell						
Union	31,004	13,816	3,945	8,454	11,470	18,163
Vance	21,890	18,600	10,400	4,770	123,600	45,892
Wake	74,250	63,000	99,633	63,030	40,844	79,909
Warren	25,757	30,932	15,856	2,086	3,780	535
Washington	12,000			2,233	6,000	7,980
Watauga	212	760	500	3,000	2,300	3,075
Wayne	165,794	236,337	181,043	77,030	145,750	149,525
Wilkes	6,400	11,343	5,871	10,216	11,050	15,625
Wilson	16,375	37,000	70,976	62,299	191,949	113,334
Yadkin		300	240	2,055	1,150	
Yancey	10,650	12,500	8,000	84,351	215,654	305,908
Totals	3,514,892	3,879,340	3,692,461	3,504,725	4,746,674	5,411,452

PUBLICATIONS

OF THE

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

BULLETINS

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*

2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 50 cents extra.*

3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*

4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*

5. The Forests, Forest Lands, and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Out of print.*

6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of print.*

7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Out of print.*

8. Water powers in North Carolina, by George F. Swain, Joseph A. Holmes, and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Out of print.*

9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Out of print.*

10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of print.*

11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Out of print.*

12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 8°, 60 pp., 15 pl. *Out of print.*

13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897. 8°, 157 pp., 12 pl. *Out of print.*

14. The Cultivation of the Diamond-back Terrapin, by R. E. Coker, 1906. 8°, 67 pp., 23 pl., 2 figs. *Out of print.*

15. Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 8°, 74 pp., 17 pl., 11 figs. *Postage 10 cents.*

16. Shade Trees for North Carolina, by W. W. Ashe, 1908. 8°, 74 pp., 10 pl., 16 figs. *Out of Print.*

17. Terracing of Farm Lands, by W. W. Ashe, 1908. 8°, 38 pp., 6 pl., 2 figs. *Postage 4 cents.*

18. Bibliography of North Carolina Geology, Mineralogy, and Geography, with a list of Maps, by Francis Baker Laney and Katherine Hill Wood, 1909. 8°, 428 pp. *Postage 25 cents. Cloth-bound copy, $1.00.*

19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglas B. Sterrett, 1905. 8°, 64 pp., 8 figs. *Postage 4 cents.*

20. Water powers of North Carolina: An Appendix to Bulletin 8, 1910. 8°, 383 pp. *Postage 25 cents.*

21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8°, 137 pp., 23 pl., 5 figs. *Postage 15 cents. Cloth copies 75 cents.*

22. A Report on the Cid Mining District, Davidson County, N. C., by J. E. Pogue, Jr., 1911. 8°, 144 pp., 22 pl., 5 figs. *Postage 15 cents. Cloth copies 75 cents.*

23. Forest Conditions in Western North Carolina, by J. S. Holmes, 1911. 8°, 116 pp., 8 pl. *Postage 15 cents.*

24. Loblolly or North Carolina Pine, by W. W. Ashe, Forest Inspector, U. S. Forest Service (and former Forester of the North Carolina Geological and Economic Survey). Prepared in Coöperation with the Forest Service, U. S. Department of Agriculture, 1914. 8°, 176 pp., 27 pl., 5 figs. *Postage 15 cents. Cloth copies 75 cents.*

25. Zircon, Monazite, and Other Minerals used in the Production of Chemical Compounds Employed in the Manufacture of Lighting Apparatus, by Joseph Hyde Pratt, Ph. D., 1916. 8°, 120 pp., 3 pl. *Postage 15 cents. Cloth copies 75 cents.*

26. A Report on the Virgilina Copper District of North Carolina and Virginia, by F. B. Laney, Ph.D., 1917. 8°, 176 pp., 20 pl., 16 figs.

27. The Altitudes of North Carolina, 1917. 8°, 124 pp. *Pastage 20 cents.*

ECONOMIC PAPERS

1. The Maple Sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina During 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Out of Print.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron, Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Out of print.*

Gives a list of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving localities; takes up the Occurrence of Copper in the Virgilina, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets, describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of clay; and under the head of "Other Economic Minerals," describes and gives Occurrences of Chromite, Asbestos, and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Out of print.*

8. **The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904.** 8°, 74 pp. *Out of Print.*

Gives description of Mines worked for Gold in 1903; description of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; Analyses of Limonite ore from Wilson Mine; the Occurrence of Tin; in some detail the Occurrences of Abrasives, Occurrences of Monazite and Zircon; Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. **The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905.** 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904 and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities; Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market; describes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nernst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum Gems, Hiddenite and Other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. **Oyster Culture in North Carolina, by Robert E. Coker, 1905.** 8°, 39 pp. *Out of print.*

11. **The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906.** 8°, 95 pp. *Out of Print.*

Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of Thorianite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-lime Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interests in Land, Phosphate Rock, Marl Beds.

12. **Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906.** 8°, 74 pp. 8 maps. *Postage 6 cents.*

13. **Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906.** 8°, 78 pp. *Out of print.*

14. **The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907.** 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining, describing Log Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of Western North Carolnia are described, giving Distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and treatment of Mica, Origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. **The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908.** 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail the Copper and Gold Hill Copper District; a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analyses of the Principal Mineral Springs of North Carolina; a description of the Peat Formations in North Carolina, together with a detailed account of the Uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. **Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, State Geologist, 1908.** 8°, 45 pp. *Out of print.*

17. **Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908.** 8°, 94 pp. *Out of print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

19. Forest Fires in North Carolina During 1909, by J. S. Holmes, Forester, 1910. 8°, 52 pp., 9 pl. *Out of print.*

20. Wood-using Industries of North Carolina, by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8°, 74 pp., 6 pl. *Out of print.*

21. Proceedings of the Third Annual Drainage Convention, held under Auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified). Compiled by Joseph Hyde Pratt, 1911. 8°, 67 pp. 3 pl. *Out of print.*

22. Forest Fires in North Carolina During 1910, by J. S. Holmes, Forester, 1911. 8°, 48 pp. *Out of print.*

23. Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *Postage 10 cents. Cloth copies 50 cents extra.*

Gives report on Virgilina Copper District of North Carolina and Virginia, by F. B. Laney; Detailed report on Mica deposits of North Carolina, by Douglas B. Sterrett; Detailed report on Monazite, by Douglas B. Sterrett; Reports on various Gem Minerals, by Douglas B. Sterrett; Information and Analyses concerning certain Mineral Springs; Extracts from Chance Report of the Dan River and Deep River Coal Fields; some notes on the Peat Industry, by Professor Charles A. Davis; Extract from report of Arthur Keith on the Nantahala Marble; Description of the manufacture of Sand-lime Brick.

24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

26. Proceedings of Fourth Annual Drainage Convention, held at Elizabeth City, North Carolina, November 15 and 16, 1911, compiled by Joseph Hyde Pratt, State Geologist, 1912. 8°, 45 pp. *Out of print.*

27. Highway Work in North Carolina, containing a Statistical Report of Road Work during 1911, by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 145, pp. 11 figs. *Out of print.*

28. Culverts and Small Bridges for Country Roads in North Carolina, by C. R. Thomas and T. F. Hickerson, 1912. 8°, 56 pp., 14 figs., 20 pl. *Postage 10 cents.*

29. Report of the Fisheries Convention held at New Bern, N. C., December 13, 1911, compiled by Joseph Hyde Pratt, State Geologist, together with a Compendium of the Stenographic Notes of the Meetings Held on the two trips taken by the Legislative Fish Committee Appointed by the General Assembly of 1909, and the Legislation Recommended by this Committee, 1912. 8°, 302 pp. *Postage 15 cents.*

30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

31. Proceedings of Fifth Annual Drainage Convention held at Raleigh, N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist. 8°, 56 pp., 6 pl. *Postage 5 cents.*

32. Public Roads are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8°, 62 pp. *Postage 5 cents.*

33. Forest Fires in North Carolina during 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester, 1913. 8°, 63 pp. *Postage 5 cents.*

34. Mining Industry in North Carolina during 1911-12, by Joseph Hyde Pratt, State Geologist, 1914. 8°, 314 pp., 23 pl., 12 figs. *Postage 15 cents.*

Gives detailed report on Gold Mining in various counties with special report on Metallurgical Processes used at the Iola Mine, by Claud Hafer; description of a Cyanide Mill, by Percy Barbour; the new milling process for treating North Carolina Siliceous Gold Ores at the Montgomery Mine, including a description of the Uwarrie Mining Company's Plant; notes on the Carter Mine, Montgomery County, by Claud Hafer; also a description of the Howie Mine and its mill; a detailed report of the Coggins (Appalachian) Gold Mine, by Joseph Hyde Pratt; a list of gems and gem minerals occurring in the United States; special descriptions of Localities where the Amethyst, Beryl, Emerald, and Quartz Gems Occur, as taken from United States Geological Survey Report by Douglas B. Sterrett; a report on the Dan River Coal Field, by R. W. Stone, as reprinted from Bulletin 471-B of the United States Geological Survey; a special report on Graphite, by Edson S. Bastin and reprinted from Mineral Resources of United States for 1912; a special report on Asbestos describing both the Amphibole and Chrysotile varieties; a report on the Mount Airy Granite Quarry; special report on Sand and Gravel, giving Uses, Definitions of Various Sands, etc., the portion of a Bulletin on Feldspar and Kaolin of the United States Bureau of Mines, which relates to North Carolina, and which takes up in detail Occurrences, Methods of Mining, and Descriptions of Localities of Feldspar and Kaolin mines in North Carolina, prepared by Mr. A. S. Watts. In this Economic Paper are also given the names and addresses of producers of the various minerals during the years covered by the report.

35. Good Roads Days, November 5th and 6th, 1913, compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 102 pp., 11 pl. *Postage 10 cents.*

36. Proceedings of the North Carolina Good Roads Association, held at Morehead City, N. C., July 31st and August 1, 1913. In Coöperation with the North Carolina Geological and Economic Survey.—Statistical Report of Highway Work in North Carolina during 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 127 pp., 7 figs. *Postage 10 cents.*

37. Forest Fires in North Carolina during 1913 and a Summary of State Forest Fire Prevention in the United States, by J. S. Holmes, Forester, 1914. 8°, 82 pp. *Postage 8 cents.*

38. Forms covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments. And Forms for Minutes of Boards of Drainage Commissioners covering the Organization of the Board up to and Including the Issuing of the Drainage Bonds. Compiled by Geo. R. Boyd, Drainage Engineer. 133 pp.

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the Departments of Civil and Highway Engineering of the University of North Carolina and the North Carolina Geological and Economic Survey. 8°, 117 pp., 15 figs., 4 pl. *Postage 10 cents.*

40. Forest Fires in North Carolina during 1914 and Forestry Laws of North Carolina, by J. S. Holmes, State Forester, 1915. 8°, 55 pp. *Postage 5 cents.*

41. Proceedings of Seventh Annual Drainage Convention of the North Carolina Drainage Association held at Wilson, North Carolina, November 18 and 19, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1915. 8°, 76 pp., 3 figs. ***Postage 5 cents.***

42. Organization of Coöperative Forest Fire Protective Areas in North Carolina, being the Proceedings of the Special Conference on Forest Fire Protection, held as part of the Conference on Forestry and Nature Study, Montreat, N. C., July 8, 1915. Prepared by J. S. Holmes, State Forester, 1915. 8°, 39 pp. ***Postage 4 cents.***

43. Proceedings of the Second Road Institute, held at the University of North Carolina, February 23-27, 1915. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1916. 8°, 128 pp. ***Postage 15 cents.***

44. Highway Work in North Carolina During the Calendar Year Ending December 31, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1916. 8°, 55 pp. ***Postage 10 cents.***

45. Proceedings of the Eighth Annual Drainage Convention. Held under the Auspices of the North Carolina Drainage Association and the North Carolina Geological and Economic Survey, Belhaven, N. C., November 29, 30, and December 1, 1915. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 90 pp. ***Postage 15 cents.***

46. The Vegetation of Shackleford Bank, by I. F. Lewis, 1917. 8°, 40 pp., 11 pl. ***Postage 10 cents.***

47. Proceedings of the Ninth Annual Drainage Convention of the North Carolina Drainage Association, held at Greensboro, N. C., November 22 and 23, 1916. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1917. 8°, 110 pp., 8 figs. ***Postage 15 cents.***

48. Forest Fires in North Carolina during 1915, 1916 and 1917, and Present Status of Forest Fire Prevention in North Carolina, by J. S. Holmes, State Forester, 1918. 8°, 97 pp. ***Postage 10 cents.***

49. Mining Industry in North Carolina during 1913–1917, Inclusive, by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1919. 8°, 170 pp. ***Postage 20 cents.***

VOLUMES

Vol. I. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy $1 extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 pl., 188 figs. *Out of Print.*

Vol. III. The Coastal Plain Deposits of North Carolina, by William Bullock Clark, Benjamin L. Miller, L. W. Stephenson, B. L. Johnson, and Horatio N. Parker, 1912. 8°, 509 pp., 62 pl., 21 figs. *Out of Print.*

Pt. I.—The Physiography and Geology of the Coastal Plain of North Carolina, by Wm. Bullock Clark, Benjamin L. Miller and L. W. Stephenson.

Pt. II.—The Water Resources of the Coastal Plain of North Carolina, by L. W. Stephenson and B. L. Johnson.

Vol. IV. The Birds of North Carolina, by T. Gilbert Pearson, C. S. Brimley and H. H. Brimley, 1918. 8°, 380 pp., 24 colored plates, 10 black and white plates, 275 text figures, one map. *Paper copies, $2.00, postpaid. Cloth-bound copies, $2.75, postpaid.*

BIENNIAL REPORTS

First Biennial Report, 1891-1892, J. A. Holmes, State Geologist, 1893. 8°, 111 pp., 12 pl., 2 figs. *Postage 6 cents.*

Administrative report, giving object and organization of the Survey; Investigations of Iron Ores, Buildng Stone, Geological work in Coastal Plain Region, including supplies and drinking waters in eastern counties, Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill.

Biennial Report, 1893-1894, J. A. Holmes, State Geologist, 1894. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1895-1896, J. A. Holmes, State Geologist, 1896. 8°, 17 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1897-1898, J. A. Holmes, State Geologist, 1898. 8°, 28 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1899-1900, J. A. Holmes, State Geologist, 1900. 8°, 20 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1901-1902, J. A. Holmes, State Geologist, 1902. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1903-1904, J. A. Holmes, State Geologist, 1905. 8°, 32 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1905-1906, Joseph Hyde Pratt, State Geologist, 1907. 8°, 60 pp. *Postage 3 cents.*

Administrative report; report on certain swamp lands belonging to the State, by W. W. Ashe; it also gives certain magnetic observations at North Carolina stations.

Biennial Report, 1907-1908, Joseph Hyde Pratt, State Geologist, 1908. 8°, 60 pp., 2 pl. *Postage 5 cents.*

Administrative report. Contains Special Report on an examination of the Sand Banks along the North Carolina Coast, by Jay F. Bond, Forest Assistant, United States Forest Service; certain magnetic observations at North Carolina stations; Results of an Investigation Relating to Clam Cultivation, by Howard E. Enders, of Purdue University.

Biennial Report, 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report, and contains Agreements for Coöperation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work, with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and counties partly or wholly topographically mapped; description of Special Highways in North Carolina; suggested Road Legislation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry Reports relating to Connolly Tract, Buncombe County and Transylvania County State Farms; certain Watersheds; Reforestation of Cut-over and Abandoned Farm Lands on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst; Act regulating the use of and for the Protection of Meridian Monuments and Standards of Measure at the several county seats of North Carolina; list of Magnetic Declinations at the county seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of Fisheries relating to the conditions of the North Carolina fish industries; report of the survey for the North Carolina Fish Commission referring to dutch or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Rude, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 118 pp. ***Postage 7 cents.***

Administrative report, and contains reports on method of construction and estimate of cost of road improvement in Stantonsburg Township, Wilson County; report on road conditions in Lee County; report on preliminary location of section of Spartanburg-Hendersonville Highway between Tryon and Tuxedo; report of road work done by United States Office of Public Roads during biennial period; experiments with glutrin on the sand-clay road; report on Central Highway, giving Act establishing and report of trip over the Highway; suggested road legislation; report on the Asheville City watershed; report on the Struan property at Arden, Buncombe County; report on the Woodlands on the farm of Dr. J. W. Kilgore, Iredell County; report on examination of the woodlands on the Berry place, Orange County; report on the forest property of Miss Julia A. Thorns, Ashboro, Randolph County; report on the examination of the forest lands of the Butters Lumber Company, Columbus County; proposed forestry legislation; swamp lands and drainage, giving drainage districts; suggested drainage legislation; proposed Fisheries Commission Bill.

Biennial Report, 1913-1914, Joseph Hyde Pratt, State Geologist, 1915, 8°, 165 pp. ***Postage 10 cents.***

Administrative report and contains reports on the work of the State convicts on Hickory Nut Gap Road, Henderson County, and on the link of the Central Highway in Madison County which is being constructed with State convicts; report on road work accomplished by the State Survey and by the United States Office of Public Roads during biennial period; suggested road legislation; a forestry policy for North Carolina; report on investigation. Timber supply of North Carolina; reports on the examination of certain forest lands in Halifax County; report on the ash in North Carolina; report on the spruce forests of Mount Mitchell; report on the forest fire conditions in the Northeastern States, by J. S. Holmes. Report on the work of the United States Forest Service in North Carolina in connection with the purchase of forest reserves and their protection; timber tests, including strength of timber, preservation of timber, timber suitable to produce pulp, distillation of certain woods and drying certain woods; suggested forestry legislation; report on the swamp lands and their drainage in North Carolina; suggested drainage legislation, report on magnetic observations made during biennial period; report on the economic value of the fisheries of North Carolina; report on the survey made in Albemarle, Croatan, and Pamlico sounds by the Coast and Geodetic Survey; suggested fisheries legislation.

Biennial Report, 1915-1916, Joseph Hyde Pratt, State Geologist, 1917. 8°, 202 pp. ***Postage 25 cents.***

Administrative report and contains special reports on the Protection from Fire of the Forested Watersheds of Navigable Streams; National Forest Reservations; forestry report on Lake Latham Farms near Mebane, N. C.; report on Forest Tract owned by the Cranberry Iron and Coal Company near Cranberry, N. C.; report on work of N. C. Forestry Association; report on Southern Forestry Congress; special report on "The Fisheries of North Carolina"; Magnetic Observations made during 1915 and 1916; Memorial Sketch of Dr. Joseph Austin Holmes.

Biennial Report, 1917-1918, Joseph Hyde Pratt, State Geologist, 1919. 8°, 110 pp. ***Postage 15 cents.***

Samples of any mineral found in the State may be sent to the office of the Geological and Economic Survey for identification, and the same will be classified free of charge. It must be understood, however, that NO ASSAYS OR QUANTITATIVE DETERMINATIONS WILL BE MADE. Samples should be in a lump form if possible, and marked plainly on outside of package with name of sender, postoffice address, etc.; a *letter* should accompany sample and *stamp* should be enclosed for reply.

These publications are mailed to libraries and to individuals who may desire information on any of the special subjects named, in most cases free of charge, except that in each case applicants for the reports should forward the amount needed for packing and transportation for mailing the bulletins desired, to the *State Geologist, Chapel Hill, N. C.*

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

[illegible] PRATT, Director

ECONOMIC PAPER No. [illegible]

PROCEEDINGS

OF THE

TENTH ANNUAL DRAINAGE CONVENTION

HELD AT

WASHINGTON, NORTH CAROLINA

MARCH [illegible] AND APRIL 1, 19[illegible]

[illegible]

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

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NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, Director

ECONOMIC PAPER No. 50

PROCEEDINGS

OF THE

TENTH ANNUAL DRAINAGE CONVENTION

HELD AT

WASHINGTON, NORTH CAROLINA
MARCH 31 AND APRIL 1, 1920

Compiled by

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

RALEIGH
EDWARDS & BROUGHTON PRINTING CO.
1920

GEOLOGICAL BOARD

LETTER OF TRANSMITTAL

Chapel Hill, N. C., July 15, 1920.

To His Excellency, Hon. T. W. Bickett,

Governor of North Carolina:

Sir:—The Tenth Annual Drainage Convention was held under the auspices of the North Carolina Drainage Association and the North Carolina Geological and Economic Survey at Washington, North Carolina, March 31 and April 1, 1920. This is the first convention that has been held since 1916 on account of the war conditions.

Since the close of the war there has been a revival in the interest in the drainage projects in North Carolina, and the papers presented at this Washington meeting and the discussions were of such interest that it is believed that they are of enough importance to warrant their being published, and it is therefore recommended that the proceedings of this Convention be published by the Survey as Economic Paper No. 50 of the publications of the North Carolina Geological and Economic Survey.

Yours respectfully,

Joseph Hyde Pratt, *Director*,

North Carolina Geological and Economic Survey.

CONTENTS

PROCEEDINGS OF ANNUAL CONVENTION OF THE NORTH CAROLINA DRAINAGE ASSOCIATION

Washington, North Carolina, March 31 and April 1, 1920.

WEDNESDAY, MARCH 31—Morning Session

PROF. M. E. SHERWIN, President N. C. Drainage Association, Presiding

The Tenth Annual Convention of the North Carolina Drainage Association was opened in Washington, North Carolina, at ten A. M. Wednesday, March 31st, the Convention being called to order by President M. E. Sherwin. The session was opened with prayer by the Reverend Stephen Gardner, and addresses of welcome to the delegates were delivered by Hon. John H. Bonner on behalf of the Mayor, who was called out of the city, and Hon. W. H. Ellison, President of the Chamber of Commerce. The response to the addresses of welcome was made by Mr. D. N. Graves of Massachusetts, who spoke as follows:

RESPONSE TO ADDRESS OF WELCOME

BY MR. D. N. GRAVES of Massachusetts

Mr. President, Ladies and Gentlemen:

I am reminded this morning that it is just ten years ago since I first came into the State of North Carolina to become interested in drainage. I have a more firm belief this morning than ever before that these ten years, which have been largely devoted to drainage and development here, have been well spent. Service is the big thing. It is, of course, right and proper that these undertakings should be organized upon a commercial basis, but it is infinitely more important that these undertakings themselves should be successful and efficient than that any one man, or any group of men, should become wealthy from them. It is this spirit of service which appeals to me in the welcome which has been given to us here this morning. Washington offers to us the services of her hospitality and of her courtesy, and we accept it in the same spirit in which it is given; and we are appreciative of it. This organization itself is an organization for service. There are no remunerations here; no salaries; and these men and these women who give their time and their service to this organization do it for the love of service. If we can get something of this spirit of service into our business and into this drainage development in which we are, all of us, deeply interested, it will not only make this work more interesting to us but more useful to posterity; and the stronger we keep this element of service in this work the greater will be the success of the work.

To the Chamber of Commerce, then, and to the City itself, we offer our appreciation and thanks for the many courtesies which we have already received and for their hospitality, and I think we have already noticed here, all of us, this same spirit of service upon the part of Washington, for this hospitality comes to us from this spirit of service.

The history of the interest in Lake Mattamuskeet project I suppose goes farther back than any connection with any other drainage district in the United States. No one apparently knows when the first people came into Hyde County and settled this country about Lake Mattamuskeet, but it must have been something like two hundred years ago. Men came in there at a very early date and began to clear down the forest and to build homes and to put under cultivation the land immediately around this Lake. The land around the Lake itself is rather high and tremendously fertile, and this undoubtedly accounts for the early settlement of this country. And it seems to me a rather strange thing that these people who first settled that country down there appreciated very, very much the necessity for the removal of the water from Lake Mattamuskeet. For away back there beyond the Revolutionary War, when this country was under the rule of England, a petition was sent to the Governor of North Carolina asking him if a canal might be built from this Lake to the sea. The people at that time thought that by building such a canal the Lake would drain away into the sea, not knowing that the bottom of the Lake was slightly below the bed of the sea. The Governor of North Carolina turned down this petition upon the ground that the State could not afford to undertake a project which would mean an increase in taxation. In 1789, immediately after the Revolutionary War, the Governor of North Carolina appointed a drainage commission for this district, the first drainage commission in the United States. It would be very interesting if we might know what the report and findings of this commission were, over 125 years ago, but the report has been lost. Nothing further was done about the drainage of this project until about 1835.

REPORTS OF OFFICERS

In the absence of Colonel Joseph Hyde Pratt, Secretary and Treasurer of the Association, these reports were given by Miss H. M. Berry, Acting Secretary.

REPORT OF THE SECRETARY

The last Convention of the North Carolina Drainage Association was held in Greensboro, November 22 and 23, 1916. The proceedings of this Convention are published as Economic Paper No. 47 of the publications of the North Carolina Geological and Economic Survey.

On February 1, 1917, there was held in Raleigh at the Chamber of Commerce, a called meeting of the Association in the interest of certain drainage legislation. The proceedings of this meeting are also given in the same Economic paper, together with the legislation which was suggested.

Because of the war and the influenza epidemics, no convention has been attempted since then.

A tile drainage contest was conducted by President Sherwin in November, 1917, and a medal awarded to W. C. Eagles of Macclesfield for the best essay on a plot for tile draining a field.

Drainage Legislation.—Since the last Convention was held, two legislatures have been in session. The General Assembly of 1917 passed two bills amending the drainage law. These are the amendments which were recommended by the Legislative Committee of the North Carolina Drainage Association, and were enacted into law practically as presented. These amendments were published in Press Bulletin No. 158 of the N. C. Geological and Economic Survey.

AMENDMENTS TO NORTH CAROLINA DRAINAGE LAW

There were three amendments passed by the Legislature of 1919, as follows:

(1) Relating to the election of drainage commissioners in drainage districts already organized; (2) substituting certain words in the general drainage act; and (3) an act extending the time for filing copies of assessment rolls by drainage commissioners. These amendments are as follows:

AN ACT TO AMEND CHAPTER 152 OF PUBLIC LAWS OF 1917, ENTITLED "AN ACT TO AMEND CHAPTER 442 OF THE PUBLIC LAWS OF 1909, ENACTING A GENERAL DRAINAGE LAW AND PROVIDING FOR THE ESTABLISHMENT OF DRAINAGE DISTRICTS AND THE ACT AMENDATORY THEREOF, BEING CHAPTER 67 OF THE PUBLIC LAWS OF 1911, AND FOR OTHER PURPOSES."

The General Assembly of North Carolina do enact:

SECTION 1. That section four of chapter one hundred and fifty-two of Public Laws of one thousand nine hundred and seventeen of North Carolina be and the same is hereby amended by striking out the word "county" where it occurs on page two hundred and ninety-two of said act in line twenty-nine on said page, and inserting in lieu thereof the word "drainage" and by inserting after the word "commissioners" in said line and before the word "as" the words "of such district," and by striking out the word "county" where it occurs in line thirty-one of said page and inserting in lieu thereof the words "said district."

SECTION 2. That section nine of the aforesaid act be and the same is hereby amended by striking out the word "county" where it occurs in line thirty-one on page two hundred and ninety-seven and inserting in lieu thereof the word "drainage."

SECTION 3. That section ten of the aforesaid act be and the same is hereby amended by striking out the word "county" where it occurs in line thirteen of said section and inserting in lieu thereof the words "said district."

SECTION 4. That all laws and clauses of laws in conflict with this act be and the same are hereby repealed.

SECTION 5. That this act shall be in full force and effect from and after its ratification.

Ratified this 10th day of March, A. D. 1919.

AN ACT TO AMEND SECTION FIVE OF CHAPTER ONE HUNDRED FIFTY-TWO OF THE PUBLIC LAWS OF ONE THOUSAND NINE HUNDRED AND SEVENTEEN, RELATING TO THE ELECTION OF DRAINAGE COMMISSIONERS IN DRAINAGE DISTRICTS ALREADY ORGANIZED.

The General Assembly of North Carolina do enact:

SECTION 1. That the last sentence in section five of chapter one hundred and fifty-two, Public Laws of 1917, which reads: "The provisions of this section relating to the election of drainage commissioners shall not apply to any drainage district already organized," be repealed and in lieu thereof the following be substituted: "The provisions of this section relating to the manner of election of drainage commissioners shall not apply to any drainage district prior to the ratification of chapter 152, Public Laws of 1917, except as provided in the sentence next to the last sentence in section 5 of said chapter 152 and in those districts the landowners shall be entitled to vote as provided by law prior to the ratification of said act. The term of office of boards of drainage commissioners in districts organized prior to the ratification of said chapter 152 of the Public Laws of 1917, and in which no election of drainage commissioners has been held under section 5 of said chapter 152, shall expire on the thirtieth day of September, 1919, and their successors shall be elected on the second Monday in August, 1919, in the manner provided by law. If for any reason the clerk of the court shall fail to provide for an election of said drainage commissioners on the second Monday in August to succeed those whose terms will expire on the 30th day of September, the said clerk shall have authority at the most convenient date thereafter to provide for such election, and in the meantime the incumbents shall continue to hold office as commissioners until their successors are elected and qualified. The length of the term of service of commissioners elected hereunder shall be as provided in section 5 of said chapter 152 of the Public Laws of 1917. This section shall not apply to the manner or time of election of the drainage commissioin of the Mattamuskeet drainage district.

SECTION 2. That this act shall be in force from and after its ratification.

Ratified this 10th day of March, A. D. 1919.

AN ACT EXTENDING THE TIME FOR FILING COPIES OF ASSESSMENT ROLLS BY DRAINAGE COMMISSIONERS.

The General Assembly of North Carolina do enact:

SECTION 1. That that portion of section 12 of chapter 67 of the Public Laws of 1911, as amended by section 9 of chapter 152 of the Pubic Laws of 1917, requiring drainage commissioners to prepare and file four copies of each assessment roll or drainage tax list, shall be deemed to have been complied with if said drainage commissioners who have heretofore assessed the lands of a drainage district shall file the aforesaid four copies of assess-

ment rolls within six months from the first day of April, 1919, said filing of assessment rolls to have the same legal effect as if filed strictly in accordance with said section immediately after the preparation of such assessment rolls by the drainage commissioners.

SECTION 2. That if for any cause the sheriff is unable to collect the amount of the assessment made by the drainage commissioners out of the lands assessed under the provisions of chapter 142 of the laws of 1909, as amended by chapter 67 of the laws of 1911, then the said assessment shall be collectible as taxes are collected out of any other property, real or personal, belonging to the person owning the land at the time such assessment was made.

SECTION 3. That where the land so assessed by the drainage commissioners under the acts mentioned in section two hereof has been purchased since the making of the assessment by a purchaser for value without notice under a deed of general warranty and said purchaser pays to the sheriff the amount of said drainage assessment which is a lien on the land purchased, then such purchaser who pays the said drainage assessment shall have a right of action against the warrantor of his title under the covenant of general warranty contained in his deed for the recovery of the amount paid.

SECTION 4. That the sheriff who executes upon property for the collection of drainage assessments under the provisions of section 12 of chapter 67 of the Public Laws of 1911, as modified by this act, shall not be liable either civilly or criminally, if he shall sell such property in good faith, even though such sale is irregular or for any cause illegal.

SECTION 5. That this act shall take effect from and after its ratification.

Ratified this 11th day of March, A. D. 1919.

Since beginning drainage in North Carolina in 1909, under the General Drainage Law, about 142 projects have been organized or proposed. Of these projects, 75 have been completed, representing 611,144 acres; 9 have been abandoned; 15 have been approved; and 59 are hanging fire or now being proposed. There is still a vast acreage of wet lands which could profitably be drained and thereby add millions of dollars to the State's agricultural values and greatly enhance health conditions.

Since the conclusion of the war, interest has again started in the formation of drainage districts, and capital will undoubtedly be more and more attracted to it as the bond market stabilizes and labor conditions improve. It is of vital interest to the State to make these sections attractive to settlers and utilize as rapidly as possible these unused areas.

It is suggested that the Drainage Association seek to greatly increase its membership; increase the annual dues to $5.00; add to its resources through contributing memberships and thus get enough money to engage actively in advertising the advantages of these drained areas,

with a view to securing desirable immigrants. There is a big field which such an organization could cover to the advantage of the land-owners and the State generally.

REPORT OF THE TREASURER

The report of the Treasurer was submitted and referred to the Auditing Committee, who audited and approved the report.

APPOINTMENT OF COMMITTEES

The President then appointed the following committees:

RESOLUTIONS COMMITTEE

P. H. Johnson, Chairman.......................... Beaufort County
I. W. Barber....................................... Surry County
W. D. Alexander................................. Mecklenburg County
J. W. Bradley...................................... Pasquotank County
Geo. T. Radcliffe................................. Hyde County
P. Matthews....................................... Chowan County
C. C. Cashwell..................................... New Hanover County
J. D. Pitts.. Burke County
R. R. Cotten.. Pitt County
W. A. Davis.. Tyrrell County
A. E. Hire... Forsyth County
J. I. Herritage..................................... Onslow County
W. P. Broome...................................... Anson County
J. J. Fleetwood.................................... Perquimans County
J. L. Cherry.. Edgecombe County

MEMBERSHIP COMMITTEE

W. D. Alexander, Chairman.......................... Mecklenburg County
C. W. Mengel .... Beaufort County
H. M. Lynde... Wake County
W. A. McGirt... New Hanover County

COMMITTEE ON NOMINATIONS AND NEXT MEETING PLACE

W. K. Allen, Chairman............................. New Hanover County
Geo. E. Ricks.. Beaufort County
W. W. Peirce... Wayne County
C. B. Spencer.. Hyde County

AUDITING COMMITTEE

John E. Shepardson, Chairman...................... Beaufort County
Wm. B. Cobb.. Tyrrell County
F. F. Cohoon.. Pasquotank County

Mr. Sherwin: I suppose this is the first meeting of the North Carolina Drainage Association that Dr. Pratt has not attended; also the first meeting to which he has not been able to give considerable effort toward its organization and the forming of its program. While I agree absolutely with Mr. Small that the work has been most splendidly done by Miss Berry, yet I feel as though, in view of his absence at this time, that we should come up with a rising vote asking Miss Berry to transmit to him, by telegram, our best wishes for his early recovery. It might make Dr. Pratt feel almost as good as if he were with us today.

In accordance with the above suggestion, the following telegram was sent:

DR. JOSEPH HYDE PRATT,
Watts Hospital,
West Durham, N. C.

The North Carolina Drainage Association greatly regrets your inability to be with the Convention and the cause of your absence. The Convention greatly appreciates the services which you have rendered the State and Nation, and wishes for you an early recovery.

(Signed) M. E. SHERWIN,
President.

The Secretary suggested that the annual dues of the Association be increased from $1 to $5. On account of the increased cost of everything the work of the Association has been very much handicapped for lack of funds.

It was moved and carried that the matter of annual dues be referred to the Membership Committee and reported to the convention.

The subject of the settlement of our reclaimed and unused areas was very fully and most instructively discussed by Mr. Clement S. Ucker of the Southern Settlement and Development Organization of Baltimore, Md. Mr. Ucker brought out some very interesting points and was listened to most attentively by the delegates.

Mr. Wm. G. Benham, President of the R. L. Dollings Company of Columbus, Ohio, made an interesting talk on the Lake Mattamuskeet development project.

Afternoon Session

MR. P. H. JOHNSON, Presiding

The afternoon session was opened by an address by Congressman John H. Small, who spoke as follows:

ADDRESS BY HON. JOHN H. SMALL

CONGRESSMAN FROM FIRST DISTRICT, NORTH CAROLINA

Mr. Chairman and Gentlemen:—I have just reached the city and have had no opportunity to collect my thoughts, and I am only going to detain you this afternoon with a few brief observations. I notice that I have the honor to preside tomorrow forenoon. I may claim your attention for ten or fifteen minutes at that time to present a serious thought upon the problems which press upon the North Carolina Drainage Association.

My thoughts go back in this connection to the years prior to 1909 when for four or five summers at farmers' meetings in the several counties in this district an expert drainage engineer came to talk to our people about the problems of drainage. For the first year or two the doctrines which he brought to our people about drainage fell to some extent upon deaf ears. Prior to that period, and during the entire history of the State, the few drainage or ditch laws which we had were primarily framed for the benefit of individual landowners. We had not, up to that time, caught the vision of the cooperative spirit in the drainage of our lands and, necessarily, drainage, up to that time, was haphazard, inadequate and inefficient. We had not learned that in these lands in the Coastal Plain Section effective drainage depends upon seeking an outlet and constructing one or more large drainage canals leading to such an outlet. Necessarily, the excavation of such large canal or canals is expensive—too great an expenditure to justify any individual landowner, no matter how large an area he might cultivate—in subjecting himself to the necessary expenditure. Finally, along about 1907 or 1908, more interest came to be manifested. Here and there an intelligent citizen, usually a landowner, came to understand the real crux of the problem of drainage; came to an understanding of the basic fact that drainage of our wet lands could not be accomplished individually and only collectively; and that number increased until, I think, in 1907 we organized this Drainage Association, of which, as the Chairman said, I had the honor to be a charter member, and among the other members who were most active in its organization was Dr. Joseph Hyde Pratt. It is a pleasure at this moment to divert and refer to the distinguished and able service to the State of North Carolina of Dr. Pratt. A native of the State of Connecticut; a graduate, as I recollect, of Yale University, he came not long after completing his University course, to this State. He was at the head of our State Geological and Economic Survey; he became connected with the activities of the State University and was one of the early citizens of the State who, already having an appreciation of the real problem involved in drainage, suggested the correlation of the civic forces of the State in an organization to promote drainage of our wet lands. Dr. Pratt was a distinguished officer in the Corps of Engineers in our recent world war; and since his return has been ill for some months. I am sure I bespeak the sentiments of every one familiar with his service to the State in wishing for

him an early recovery; a restoration to his normal health and a return to the discharge of his duties, in which he has in the past rendered such signal services.

So, in 1907, the North Carolina Drainage Association was organized and in the following year at a session in 1908 a committee was appointed to draft a law to be submitted to the next session of the Legislature. Your speaker had the honor to serve as Chairman of that committee and for one reason or another, the other member of the committee could not serve, so that the Drainage Law as presented to the General Assembly of our State in 1909, was the work of the speaker, with the aid of the then Supervising Drainage Engineer of the United States Department of Agriculture, Mr. J. O. Wright. The Legislature of 1909 passed that law substantially, or literally as I recall, as it was presented to them. At the time of the enactment of that law there was no other southern State which had a modern drainage law except the State of Louisiana. Our law has been substantially amended in many respects as its weaknesses or defects appeared from time to time, until we have the drainage law of our State in its present form. It is rather complimentary to our State to be able to say that, since then, Virginia, South Carolina and Georgia have enacted drainage laws substantially similar to ours; whether other southern States have done so, I am not advised.

That law has been a beneficence to North Carolina. We have, according to the report of the soil experts of the Bureau of Soils, of the Department of Agriculture, in the Coastal Plain section of this State, as fertile lands as those that exist in the deltas of the Mississippi. Without cooperative effort they could not be drained; without drainage they were valueless in so far as they had capacity to produce. Many of these lands at that time had been cut over, and the cut over area has been increased since that date. I do not know the area of these swamp lands which have been reclaimed and are drained. Miss Berry tells me a little over 600,000 acres of lands; that means land which had formerly been set in forest, from which the merchantable timber had been cut and which had not theretofore been cultivated. Lands which in 1909 had a market value of about fifty cents an acre, had no earning value whatever. The owner of it simply had the burden of the taxpayer with no profit whatever. So far as I know, without an exception, all of these various areas amounting in the aggregate to 600,000 acres which have been drained, have proven productive wherever they have been scientifically and efficiently drained, so that the water can be carried off with reasonable promptness. They have been cultivated and they became valuable. I presume it is a fair statement to make that the market value upon an average of these lands today is $50 an acre; and $50 times 600,000 is $30,000,000. So that there has been added to the assets of the State lands which theretofore were not worth more than $600,000, or certainly $1,200,000; which have increased in value up to $30,000,000.

Any public movement which can set forth to the people of the State an increment to the economic wealth of our people to that extent is entitled to the favorable consideration of the people of North Carolina; and yet this work is only in its infancy.

May I detain you now for just a moment upon the basic and elementary conditions necessary for the drainage of our lands?

Necessarily, as I said, with these lands lying at this slight level above tidewater, they can only be drained by carrying the surface water to a common outlet, and that involves expense. The basic theory upon which our drainage law is founded is that of cooperative effort, by which the landowners in a given area—an area as large as is consistent with the essential of carrying the water to a common outlet, whether that be one thousand, or ten thousand, or fifty thousand acres. Unless that disposition to cooperate between landowners exists, the possibility of draining these areas is killed at the outset. There must be either a sufficient number of landowners or a sufficient proportion of area, in order to institute the drainage proceedings. And if there is even one, or certainly if there are several landowners, who are opposed to the formation of a district, the proceedings may be held up or indefinitely postponed.

I shall not go further into the details of the drainage proceedings, as it would be superfluous, as most, if not all, of you are famliar with them. We must issue bonds commensurate with the cost; bonds to be divided into ten annual payments; plans must be made by a competent engineer; they must be executed by a contractor familiar with such work, under the supervision of the drainage engineer and the board of drainage commissioners.

I would like now to present one other thought in connection with drainage. So far, this drainage movement has touched only our unreclaimed swamp lands, lands which have not theretofore been subjected to cultivation. This is only half of the drainage problem of eastern North Carolina, if half. We must go farther and apply the drainage law to lands which are already under cultivation, but inefficiently drained. There are hundreds of thousands of acres of cultivated land in eastern North Carolina, some of which have been under cultivation for a hundred years, which are uncertain as to crop production; lands of which the owners have said, once in every four or five years, that their crops have been drowned out and they do not expect to raise enough to pay for the labor. That is not profitable farming. It is an unwise use of land; it is engaging in business upon a plan which no business man in any other vocation would be justified in entering upon. Suppose we told a merchant who came to our town that once in every four or five years he would make no profit; every two or three years profits would be cut in two—it would not only discourage him, but if he were a wise man it would be sufficient to prevent him from coming to our town and locating as a merchant. If we set out to induce any man of industry to engage in any line of manufacture in this or any other community and he was confronted with the probability that in one year out of five he might not make any profit and every one or two years his profits would be greatly reduced, of course the business man, the manufacturer, the merchant knows that neither he nor any other sensible man regardful of his own future interest would for a moment consider locating in any such community. And yet for generations, in many instances for a hundred years we have been cultivating fertile lands here in eastern North Carolina which were subject to the same contingencies, and we have gone ahead looking upon it as providential or impossible to prevent. What is the only conclusion deduced by wisdom? It is this, that these lands, cultivable, must be made certain in their productive capacity every year and therefore profitable every year. And when we can present this thought clearly and succinctly

and impressively to the owners of these wet lands, which during these years have been uncertain of production and therefore had their profitable character impaired, they will be willing to join and cooperate in the formation of drainage districts for the draining of these lands already under cultivation.

In spite of the low level of our lands in eastern North Carolina, except in a very few instances, they may be drained by gravity. It is astonishing, under the guidance and supervision of an expert drainage engineer, what a slight fall is necessary for the efficient drainage of lands because the water, often with the slightest fall—a few inches to the mile, if the ditches are laid out by a scientific engineer and the excavation is made according to the specifications—will carry the water away and carry it away rapidly, the more water the better flow. Only here and there, in a few of the extreme eastern counties, is it necessary to resort to diking and pumping in order to drain the lands; but wherever it is necessary, if the lands are sufficiently fertile and productive the expense of diking and drainage by pumping is justifiable.

If any of you have been in Louisana you have had the opportunity to observe what I have seen. I have seen drainage districts of large areas lying on or near the banks of the Mississippi River. The levee constituted one of the banks of the .... District. Great pumps were installed which took the water from the bottom of these lands, upon which I have seen sugar cane growing extensively with great success. There were lands which were level with the water in the Mississippi River, or were three or four feet below and under flood conditions thirty feet below the level of the Mississippi River; and the beauty of the lands was that they neither suffered from drought nor flood. They could control the floods; they never suffered from drought because all they had to do was to start the pumps and the supply of water was sufficient to keep the soil sufficiently moist for the growth of vegetation. And they were profitable lands, and they made good crops every year.

And these lands, too low to be drained by gravity and upon which drainage is only possible by diking and pumping in this way, are a liability. When I was out at the St. Louis Exposition I saw a booth filled with the products from one of these States having both arid and semi-arid lands. Some of you may have visited this booth and saw an inscription above it. It ran something like this: These agricultural products (within the booth) were grown upon arid and semi-arid lands. You who live in other sections have to depend upon Providence—we depend upon the skill and the genius of man in having harnessed and conserved the water and given these crops the moisture in accordance with their needs for their growth and maturity. And one of the advantages, as I said, wherever you find lands which can only be drained by diking and pumping, is that you can rely upon getting good crops every year. Our people hesitate to assume burdens. I have talked with good citizens, intelligent landowners, living in a proposed drainage district and some man had gone to them and told them not to go into this drainage district; that it is only a scheme for some of these rich landowners to get their lands away from them and keep them. I think they believed it. I think the drainage of these lands costs in the average from five to seven dollars an acre which is divided into ten payments, so

that the annual cost would not exceed 60 to 70 cents per acre; and although that represented, even five years ago, less than a bushel of corn, (and now corn sells for $1.65 a bushel) they hesitate to impose upon their lands the necessary expenditure in order to drain it and make production safe. I had what I think was the great good fortune five or six years ago, to go along the Pacific Coast from Seattle, Washington, to the lower edge of California below San Diego, mostly by automobile. I went through the far-famed Sacramento and San Joaquin Valleys; and then for a time into the hottest place I think I ever visited on earth, the Imperial Valley where the thermometer has no hesitation in going to 110° and 115°; and in this Valley most of the lands are semi-arid. They had to install pumps to pump up the water to put upon their lands in order to produce crops. Fortunately, in the Cascade Mountains just above the upper valley region, they have water power which furnishes electric energy at reasonably cheap rates, but even under those conditions those people have an annual charge of from $2 to $6 per acre every year in order to put the necessary water on their lands to produce crops. Yet they do cultivate the lands and make money. In comparison with this, you can see how greatly we are blessed here in eastern North Carolina with the average precipitation which we have; the rainfall and sunshine and the distribution of heat, the elements which are so necessary for crop production.

I have had an opportunity to visit Texas and its famous lands; I have seen the deltas of the Mississippi and I have just told you something about the Pacific Coast. Taking all the elements which enter into successful agriculture into consideration, I do not believe that any section of the country is more greatly blessed than eastern North Carolina. In many sections which are large producers of agricultural products, they are not nearly so greatly blessed as we. If we are not succeeding as we ought; if we are not producing per acre and per unit of cost as we ought, the fault is not in our natural resources—our soil, our climate, our precipitation—but in ourselves. I think it was the great Shakespeare who said, "It is not in our stars but in ourselves that we are underlings." A wise man occasionally indulges in casting up his assets, because every wise man wants to know what are his faults and weaknesses and defects. Our strong points will take care of themselves. It is our weaknesses and defects which demand our attention and care. But we are progressing in eastern North Carolina; we are moving forward. Rev. Jasper, the negro preacher who lived in Richmond, preached a sermon which was entitled "The sun do move." We are not moving in the sense which he meant, but the people of North Carolina are moving and moving in the right direction.

Gentlemen, we ought to get behind all of these constructive movements. I believe in the idea of a man encouraging himself and getting the encouragement of his fellows; who endeavors to help his community and to get behind the car of progress. I have never had any special ambition for brilliancy; have never specially desired to shine; but I know that the greatest satisfaction I have gotten out of life—and I believe the same is applicable to every other man—is to have that pleasing sensation and that delightful contentment which comes from touching elbows with his fellows, joining hands with his kind, and helping to build up the community and make a better State and a better Nation.

Gentlemen, I always like to present bouquets to persons while they are living, and as I did not say it in the right place, I want to say it now, that while general recognition is being given to the fact that the women of North Carolina are more actively coming into participation in the various lines of constructive work that make for the upbuilding of our communities and our State, and while there are many ladies who are deserving of specific mention, it gives me great pleasure to call your attention to the Acting Secretary of the North Carolina Drainage Association, Miss H. M. Berry of Chapel Hill; who is also the Acting Secretary of the North Carolina Good Roads Association. During the illness of Dr. Pratt his duties have been most efficiently performed by his substitute, both as Secretary of this Association and of the North Carolina Good Roads Association. I hope that many other women will imitate the good example of Miss H. M. Berry, and of other progressive women of the State.

Now, gentlemen, my talk this afternoon has of necessity been somewhat rambling, and yet my heart is very much in this movement. And in conclusion I do ask you to consider that last thought which I presented—the necessity of draining our cultivated lands in eastern North Carolina. If we can add to the productive value of these lands ten per cent, it would run into millions of dollars, and millions of dollars increment in agricultural products means millions of dollars increased wealth to the State.

We have many progressive merchants in this town for example, men who know how, who know the job; and yet they do not add one dollar of wealth to this community. We have lawyers, doctors, men who are engaged in every vocation, non-productive in character, and while they are necessary for our convenience, they are non-producers of wealth. I see a gentleman over there who does a large wholesale and brokerage business. We are very proud of this man in our community—but not one dollar of wealth does he create. The only two classes of men, substantially, who bring wealth to our community are the men who manufacture and the men who produce products from the soil. They are the men who create wealth. The little farmer who produces one bale of cotton and brings it to the market and sells it for $150 or $200, he is the man who commands gold in London and in the other manufacturing textile centers of Europe, and in the same centers in our own country. He has produced something which demands $150 or $200 in new money and adds that amount to our wealth here. And every dollar's worth of products which are sold in outside markets, grown upon this reclaimed land adds that much to the wealth of eastern North Carolina, and so if we can add ten per cent to the productive value of these lands which are already under cultivation, we will have added millions of dollars to the wealth of our State. And for years to come, longer than anyone in this generation can live to see, the dominating industry in North Carolina will be agriculture. Any man, whether he be merchant, banker, doctor, lawyer, engineer, engaged in any profession, if you please; he by his brain or his industry, can help the farmer or add to our manufacturing industries and will prove a boon and a blessing to the people of North Carolina, and will deserve the good will of his fellows in the community and in the State.

I failed to make a statement which I desired to make: Mr. A. F. Lever of South Carolina is here and is on the program for tomorrow morning. Mr. Lever was a member of the House of Representatives for 18 years, and during about six years of that time was Chairman of the Committee on Agriculture and was considered one of the best equipped chairmen of that Committee who has ever served. He was Chairman of the Committee at the time the Agricultural Extension Bill was passed, a law which I think is the most constructive law that has ever been passed by Congress in the interest of agriculture. He endeavored to have passed just before he went out of the last Congress a bill framed along the line of the Agricultural Extension Law in the promotion of rural sanitation and health. I greatly regret it did not become a law. About six months ago Mr. Lever was appointed by the President a member of the Federal Farm Loan Board, upon which, since that time, he has been serving with distinction.

That is only preliminary to the statement I was going to make: Mr. Lever is on the program for tomorrow morning and I would suggest that every man who lives on the farm or who is directly or indirectly interested in agriculture be out tomorrow morning to hear Mr. Lever. If I were a farmer, knowing Mr. Lever as I do, I would subject myself to some inconvenience to attend.

I hope there will be a large attendance tomorrow morning.

THE RELATION OF FLOOD CONTROL TO DRAINAGE

By THORNDIKE SAVILLE*

Introduction

The engineering problems relating to drainage have by no means been completely solved. The excellently designed drainage systems which have done so much to make agriculturally useful vast tracts of swamp and overflow land in this State have brought in their train difficulties of maintenance and regulation which bring new problems to the engineer. It is stated that in this State many large drainage canals, important portions of the system of which they are a part, have been practically destroyed through floods and lack of upkeep until they are nearly useless for the purposes for which they were designed.

How often it is that a large canal or ditch, the single outlet perhaps from a considerable district, having been constructed at great expense, has its efficiency greatly impaired by a single flood, and if not constantly maintained, it soon becomes quite choked. This particular engineering problem therefore resolves itself into two factors: first, the need for information relating to flood flows and the design of adequate cross section of ditch to care for them, and; second, the possibility of preventing or modifying the floods.

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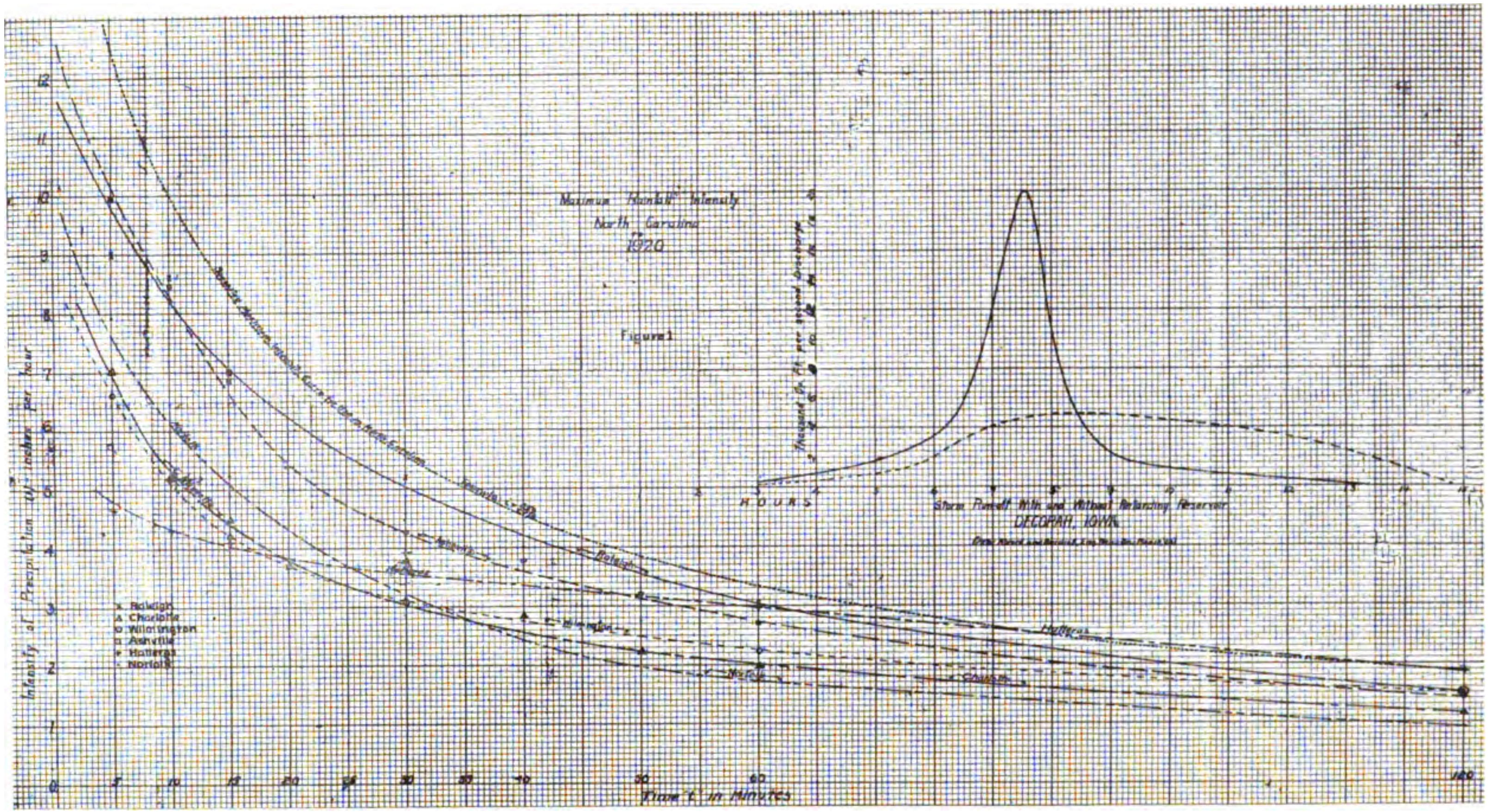

Maximum Rainfall Intensity
North Carolina
1920
Figure 1
Raleigh
Charlotte
Wilmington
Ashville
Hatteras
Norfolk
Intensity of Precipitation (i) inches per hour
Time 't' in Minutes
HOURS
DECORAH, IOWA

Figure I.

Flood Data and Design

Data relating to flood flows is unfortunately rather meagre in this State, particularly in the sections devoted to drainage. For this reason I wish to try to impress the drainage engineers and managers here with the importance of the subject, and see if we cannot begin to collect this information. A good beginning, and indeed about the only available data relating to run-off in drainage districts in this State has been recently published by Mr. Lynde, as a Bulletin of the United States Department of Agriculture, and is entitled "Run-off Investigations on Third Creek, Iredell County, N. C." For proper design of drainage ditches and the accumulation of data relative to flood flows we should begin to collect systematically for each drainage district information on the amount of rainfall, the amount of run-off, the intensity of rain-fall over short periods of time and the frequency of floods of given magnitude. All of these phenomena vary with location, cultivation, climate, altitude, topography and other factors, and the use of data from one district for the purpose of design in another district must be very carefully considered in the light of climatological influences.

Drainage ditches should be of ample cross-section to carry the average flood flow with no erosion of sides or bottom. The monthly rainfall is usually available at some place in the district for a number of years. Then measurements of run-off or discharge, taken over two or three years, will give fairly reasonable figures as to the percentage which the rainfall is of the run-off. These percentages may then be applied to the rainfall statistics, and the approximate maximum flood discharge over a considerable period of years can be obtained. Such figures are, of course, by no means accurate, and should be used with a wide factor of safety. They are, however, more trustworthy than most empirical formulas which are commonly used. The measurements of actual run-off by means of weirs or other devices should be carried on continuously—and then in a few years at least the average flood discharges will be known. It is rarely economical to design a drainage ditch to carry the absolute maximum flood which occurs only once in a number of years, since the cost of infrequent repairs is in this case less than the cost of a larger cross-section.

In the Piedmont region especially, the streams are subject to sudden rise after rains, and quickly return to normal. They are what is called "flashy," having a high rate of discharge for a short period of time. To prevent erosion, the ditches must be adequate to take the ordinary sudden flow which comes after heavy rains or thaws. The intensity of the rainfall over short periods of time then becomes of great importance. In Figure 1 is shown such intensities for all stations in North Carolina which are equipped with a tipping bucket rain gauge. It will be at once evident that the intensity of rainfall over short periods of time (and consequently the run-off and sudden rise in streams and drainage ditches) varies greatly in different parts of the State. Thus in the region about Charlotte ditches need not be of such great extra capacity for flood flow as near Raleigh, nor need the banks be on as gentle slope. Also the extreme rate of rainfall (and thus to a somewhat less extent the flood run-off) about Hatteras is considerably greater for periods between one and two hours, than about Charlotte. It is believed that a careful study of these curves will prove very suggestive to drainage engineers along a number of lines which cannot be entered

into here. They are of even greater importance in the design of storm sewerage systems for towns and cities. The curves should be used with a considerable factor of safety, since the observations on which they are based have in most instances only extended over a period of about 15 years. Moreover, the stations are not numerous enough to furnish data for *every* part of the State.

The compilation of data relating to flood frequency is also important, but can only be touched upon within the scope of this paper. To know how often a flood of given magnitude in a drainage system may be expected, is to learn at once how large a ditch to provide. Can we afford to have our ditches partially destroyed by the flood which occurs once in ten years, or shall we design so that they will be eroded only once in fifty years? What is the average flood discharge that we must provide for? What effect do drainage operations in the upper part of an area have in increasing the number and magnitude of floods lower down? These are important questions in drainage engineering which should be considered in the design of large systems.

Flood Control

After all, can we not, instead of spending money enlarging drainage ditches to take occasional floods, or in repair of ditches damaged by floods, so control the run-off on a drainage area as to deliver a fairly constant flow, or at least a flow which shall not surpass a certain predetermined amount? It is at least economical for us to expend a sum on the construction of flood control devices, the interest on which would serve to keep in repair and maintain drainage ditches injured by floods. Usually much more may be properly expended on flood control, since drainage systems frequently cause increased frequency and magnitude of floods in districts down-stream, and claim for damage may result. With the present high cost of labor it becomes increasingly desirable to make drainage ditches as nearly as possible of only sufficient size to take the normal flow and to prevent erosion of these by flood flows.

The *prevention* of floods differs from the *control* of floods. It is the latter in which we are interested. The problem is to so regulate the discharge of flood water to a stream that it will rise only a predetermined amount beyond its normal level. For this purpose it is necessary to study the catchment basins of the tributary streams.

It is necessary to know their rate of flow in flood, the time interval which their flood crest takes to reach the main stream, and the effect of the various tributary floods on the flood crest in the main stream. It is when the flood crests from a considerable number of tributary streams reach the main stream at nearly the same time, that great floods result. Often by straightening and widening channels the delivery of flood waters from some tributaries may be hastened and the flood in the main stream reduced in magnitude. Since the total amount of water to be delivered is not greatly affected by such measures, the duration of flood in the main stream will be extended, though its magnitude is decreased.

When the measures noted in the preceding paragraph are ineffective or impossible to achieve, it becomes necessary to construct retention reservoirs. By this is not meant necessarily the creation of large impounding reservoirs by high dams. It is frequently possible on small streams to erect low dams

on the tributaries, such that the flood waters may simply be retarded to a sufficient degree to prevent simultaneous discharge of flood crests to the main stream. In many instances in drainage projects it is possible to place one or more such barriers on the main stream itself. The construction of such retention basins is probably best effected by a somewhat similar procedure as is being applied on a large scale in the Miami Conservancy District near Dayton, Ohio. This method consists in constructing retarding basins at selected points on the tributaries and main stream. In the case of drainage districts served by a "flashy" stream, a low dam may be located at an appropriate place with a culvert opening in it. During normal flow the culvert discharges the waters of the stream as if no dam were there. During flood flow the discharge of the stream increases beyond that for which the culvert is designed and water is impounded behind the dam. The culverts then discharge under a hydrostatic head and are so designed that they will deliver water at such a rate as to keep the height in the main stream below a predetermined level. As the flood flow decreases the culverts continue to discharge until the impounding basins are empty. Such a scheme may be quite inexpensive as compared to elaborate construction of levees and increased size in ditches and canals to take the flood flow.

The suggestions in the preceding paragraph relate primarily to the construction of low inexpensive dams to create retarding basins. A similar control of floods may be obtained by the construction of higher dams creating large storage reservoirs. Here the reservoir may serve the double purpose of flood regulation and power development. Such structures are relatively expensive and are economical only under conditions of good dam site, fairly large normal flow of the stream, and a market for the power. There are doubtless some situations in North Carolina, particularly in the Piedmont District, where such developments would be profitable. The utilization of our smaller waterpowers is becoming increasingly important, especially in the cheap production of electric power for promoting conditions in the rural districts equal in convenience and comfort to those in the city. The coordination of waterpower developments and flood regulation in drainage districts is one of the more practical means of meeting this problem.

SOME DRAINAGE PROBLEMS IN THE "GREAT SWAMP AREA" OF NORTH CAROLINA

BY H. M. LYNDE, Senior Drainage Engineer, U. S. Bureau of Public Roads

In this paper, the writer will endeavor to outline some features of drainage in the "Great Swamp Area" of North Carolina, about which all interested in the reclamation of these lands will probably agree need consideration, if farm drainage is to be successfully accomplished. For, is it not true that the ultimate end of all drainage improvements is the drainage of the individual farm? It will probably not be out of place to give a brief description of conditions before discussing the problems.

Description.—What may be called the "Great Swamp Area" of North Carolina is a great connected swamp which covers most of the

peninsula between Albermarle and Pamlico Sounds. It is a compact area of practically one great body of peaty land, about 40 miles long and 60 miles wide, situated in Dare, Washington, Tyrrell, Hyde and Beaufort counties. There are other areas in the State of the same general character, but they do not cover such an extensive area in one body.

The swamps are plateaus, or tablelands, lying at a higher general level than all or nearly all of the adjacent firm land. Surveys indicate that they have an elevation ranging from 8 to 20 feet above the sea level, highest in the center and sloping gently at the rate of about 1 foot to the mile toward tide water, with a slightly greater rate of fall as the water is approached.

These swamps are not bottom lands in the generally accepted sense of this term. All the rivers and streams in this region have their heads in and derive all their supplies of water from the swamps, and discharge themselves outside. There is no stream, so far as the writer is aware, which flows from the outer lands toward the swamps. In the interior and on the highest surface of the swamps are lakes of considerable size, such as Lake Phelps, Pungo Lake, Alligator Lake and Mattamuskeet Lake.

Much of the merchantable timber, consisting of gum, cypress, some juniper, poplar, etc., has been cut, and the region is now in a state of cut-over timber land. The kind of trees growing on these swamps, as stated by natives of this section, usually is a fair indication of the qualities of the soils after they are drained. The best lands have black gum or black gum and cypress, for their principal growth, and usually indicates the near proximity, within a few feet of the surface, of a more or less clayey subsoil. Lands growing juniper have a soil, consisting to a large extent, of unrotted peat, with a subsoil of sand.

Progress of Drainage.—Until very recent years, little attempt has been made to drain and utilize the actual swamp areas of this region. However, there are some exceptions. Probably the earliest and most extensive successful attempt at such improvements surround Lake Mattamuskeet, in Hyde County. This, and a few other places on the borders of the swamps, comprise about all the early attempts. No great progress was made in the drainage of the large areas until the passage of the State Drainage law in 1909; the past ten years have shown wonderful progress.

Since the passage of this law, drainage districts covering a total area of approximately 220,000 acres, have been organized in this region. It is estimated that, exclusive of Lake Mattamuskeet, about

70,000 acres are drained or in process of being drained with canals one mile, or one-half mile apart. Probably at least 20,000 acres of land have been developed beyond the stage of constructing canals. With the exception of Lake Mattamuskeet, which cannot strictly be termed swamp land, all the swamp districts are being drained by gravity, and all are above 10 feet above sea level.

General Method of Drainage

The drainage of these swamps is accomplished by the construction of canals, one mile apart in some, and one-half mile apart in other districts, 6 to 9 feet deep, with nearly vertical sides and bottom widths of from 14 feet upward. These lateral canals empty into main canals which in turn empty into and through the many estuaries on tide water level in the sounds bordering the coast of this region.

Two methods of arrangement of the ditches for internal or farm drainage are being used. The first consists of parallel ditches 330 to 660 feet apart, extending from canal to canal. The second consists of a main ditch every quarter mile extending from canal to canal with laterals at right angles to it, 330 to 660 feet apart and one-quarter mile long. These field ditches, as ordinarily cut, are 2 feet wide on the bottom, 4 feet wide on top, and 3 feet deep. On account of the flatness of the land, the ditches, in order to obtain fall, are necessarily 4 to 5 feet deep near the canals.

In the older districts, it has been found necessary to construct field ditches closer together than 330 feet. The wider spacing does very well while the land is in process of development, that is, for clearing and "stuck corn," but for cultivated crops, better drainage and perhaps closer spacing, are desirable. What may be called the *complete* drainage of these lands is something which has yet to be worked out. Deep tile drainage is working very satisfactorily on the experimental farm of the North Carolina Department of Agriculture at Wenona, N. C. The subsoil on this farm is a clay at a depth of 4 to 5 feet below the surface.

Adequacy of Drainage

In discussing this subject, something more than the mere removal of surface water must be considered. There is no question that practically all the main and lateral canals constructed in this region are large enough to do this, but it is believed that some of them should be deeper, or else intermediate canals be constructed, especially in the older districts.

In flat districts, the first consideration in the design of drainage canals should be depth, else satisfactory farm drainage cannot be obtained. The minimum depth of a ditch for farm drainage should be 3 feet, and the minimum grade not much less than 0.10 foot to the hundred. For a ditch one-half mile long, 3 feet deep at the upper end, this means a depth of 5.6 feet at the outlet. To allow for silting and other conditions, it is believed that the outlet canal should be dug at least 3 feet deeper than this. If underdrains are to be installed, a good depth is especially necessary since underdrains will, in most cases, need to be laid at a greater depth than 3 feet, in order to rest on solid bottom. Also on account of the possible settling of the topsoil, the actual depth of drainage will be still further reduced.

It will thus be seen that if the canals are one mile apart, it will be necessary to have them deep in order to provide for satisfactory farm drainage, and if any arrangement of field ditches other than lines at right angles to the canals is adopted, they should be still deeper, since the distance from the upper end of the last drain to the outlet is longer. A spacing of canals one-half mile apart, dug 10 feet deep is believed to be logical for these districts. Probably all the districts will ultimately have to adopt this spacing if the best drainage results are to be expected.

Maintenance of Canals

The maintenance of drainage canals, like that of public highways, will generally be neglected until an officer is employed at a regular salary who will make this work his first business. It is desirable to have thorough inspections of the canals made regularly, at least twice each year, to be followed promptly by report to the Drainage Commissioners. These reports should show definitely the condition of the canals, and recommendations in detail for the work to be done.

Some of the matters which need attention in order to keep canals up to their highest efficiency are the periodic removal of logs, stumps, silt bars, plant growth, and debris of all kinds. Foot logs, fences, and bridge supports should not be permitted in the channels. The outlets to field ditches need protection. An effort should be made to secure the growth of some suitable grass that will make a tough sod on the banks, so as to prevent erosion.

In average drainage canals, with good fall, a small amount of work as described above, done annually, would probably keep the canals in good order permanently. In the "Great Swamp" districts, however, there are certain conditions which may require the redredging or deepening of the canals a few years after they have been constructed.

The amount of this reconstruction work and whether it will be required at all, will probably depend to a large extent, upon the depth of the canals in the first place. It is believed by the writer, that it is easier and cheaper in the long run, to dig the canals deep at the outset of the work than attempt to deepen them afterward. Some clean out work may be needed, but probably no redredging.

The great difficulty in all the drainage systems in this region seems to be the inability to secure a sufficiently rapid flow of water to make them self-cleaning, because only flat grades are obtainable. Since the canal velocities probably never exceed 1 foot per second, unless flowing more than 3 feet deep, very little scour can be expected. The maximum velocities at flood stage seldom exceed 1¾ feet per second; in times of low water the flow is very sluggish.

During the first year or so after construction, the canals are subject to a great deal of filling, due to the loose, unsettled condition of the spoil banks, berms, and slopes. With the development of the land, the numerous field ditches bring in a great deal of sediment which forms silt bars. The result is the formation of a blanket of silt on the bottoms of the canals, much of which cannot be removed by the slow moving water, and which furnishes an ideal seed bed for weeds, willows, cattails, and other vegetation. Many of the canals are necessarily much larger than required to accommodate the flow, because they cannot be constructed economically otherwise than by large machinery. Canals carrying the least amount of water have been found by experience to deteriorate the fastest, they soon fill and their bottoms grow up in thick vegetation.

The deterioration of new canals is believed to be greatest during the first three years. There seems to be no way to prevent a certain amount of filling, even though contractors use all reasonable precautions in dredging. If all canals could be dug downstream without having to resort to dams, and the work proceed steadily, it seems reasonable to expect that a large amount of the sediment would follow the dredge and be carried to the outlet at the time of construction. If possible, no opportunity should be offered for the sediment to settle.

At the end of about three years time, the banks have generally become stable, and the amount of sediment brought in by well established field ditches is comparatively small. At this period of the district's history, the question often has to be decided whether the canals need redredging, cleaning out, or deepening. Any future sediment which may come into the canals may reasonably be expected to come largely from the construction of new field ditches.

To reduce to a minimum the amount of sediment carried to the canals from the field ditches, the arrangement of having a collecting ditch every quarter-mile, with field laterals at right angles to it, as used in some districts, is advantageous. This arrangement, it is true, cuts the land into smaller fields than where the ditches extend from canal to canal, but it is believed that the plan would prevent a great deal of silting in the canals and confine much of the maintenance work to the field ditches themselves.

The problem of how best to clean out the canals, is one yet to be solved. The material in the bottom of the canals is a soft deposit, known as "slur" or "soup," always in a semi-fluid condition, even in the driest seasons. There seems to be no machine equipped to remove this kind of material satisfactorily. Hand work is not economical, and it is doubtful if this material can be handled with shovels. Redredging probably does not remove much of the "slur," it simply deepens the canal by the removal of solid material beneath it, and the "slur" settles into the excavated space.

Several types of machines have been suggested for deepening the canals, but none of them can be said to be exactly suited to the conditions. The type of machine needed seems to be one which does not require water to float it, does not disturb the banks, and is equipped with a bucket which does not leak. The nearest approach to these requirements is a grab bucket excavator, which can travel along one side of the ditch beyond the waste bank, or in the road where there is a road, fitted with a long boom, and a clam-shell or orange-peel bucket, which can be raised vertically.

The floating dipper dredge is the only type of machine which has been used so far, but there are several objections to its use. The dams built to increase the depth of water in the canals to float the dredge, cause damage by interfering with the drainage of some of the lands. The weight of the spuds on the banks, and the passage of the dredge boat through the canal are likely to disturb the banks making them liable to erosion. A centrifugal pump, mounted either on a hull or on the bank has been suggested, but it is doubtful if there will be sufficient water during dry seasons to operate even a small suction dredge, since a considerable amount of water is required to float the solids that must be removed.

Conclusion

In these brief statements, an attempt has been made to outline what seems to the writer to be the problems of greatest importance. In the last analysis, the problems really resolve themselves into one

problem, namely: the maintaining of a good depth to the canals for efficient farm drainage. It may be that there is a limit at which the depths of these canals can be economically maintained, in which case, the distance apart will need to conform with this depth.

Ultimately, much of the land will be tile drained. Canals one mile apart would need to have an effective depth (from the ground surface to the top of the "slur") of 10 feet in order to serve as satisfactory tile drainage outlets, while for canals one-half mile apart, 8 feet would be sufficient. It seems difficult to obtain a permanent effective depth of 10 feet, even after redredging, hence a closer spacing than one mile apart will be required when tile drains are installed, unless the drains are laid on exceedingly flat grades and each drain given a separate outlet.

It is hoped that this paper will be freely discussed; the writer realizes that there can be differences of opinion regarding the proper spacings and depths for the canals, especially during the development stage of these districts.

The afternoon session was closed with a general discussion of the Problems of the Drainage Contractor, and an announcement by Prof. Thorndike Saville regarding the proposed Federal Public Works Department.

Evening Session

At 7:30 in the evening Dr. Chas. E. Low, Superintendent of Health of New Hanover County, gave an illustrated lecture on "Malarial Control," which was followed by a talk by Mr. Clement S. Ucker in regard to the work of the Southern Settlement and Development Organization, and a short talk by Mr. W. A. McGirt in regard to the North Carolina Landowners Association.

THURSDAY, APRIL 1—Morning Session

CONGRESSMAN JOHN H. SMALL, Presiding

The Convention was called to order by President Sherwin and Mr. Asbury F. Lever of the Federal Farm Loan Board was introduced by Congressman Small, as follows:

MR. SMALL:

Every one likes to know something of the personality of the gentleman who is to speak to them, and it gives me pleasure in presenting your next speaker to submit some brief description of his activities. He is a native of our neighbor State, South Carolina. For eighteen

years he was a representative in Congress. And I might say, if he will permit this personal mention, that, like so many genuine Americans, he was reared on the farm, and without some of the advantages which come to many young men; he has made for himself, through a life of service, a most enviable reputation. As a member of the House, I think he was, during his entire time of service, a member of the Committee on Agriculture, and for six years or more was Chairman of that Committee. The duties of that Committee, coupled with his love for the solution of problems involved in farm life, made him a student of the subject, and he was recognized as member and Chairman of that Great Committee on Agriculture as being unusually well qualified for the duties of the position. Some of the best legislation which we have had in the interest of agriculture in its broad sense was formulated and enacted into legislation under his guidance. I might refer, particularly, as I did yesterday, to the Agricultural Extension Act which many students of the subject regard as the most forward and constructive piece of legislation for agriculture which has ever been enacted by Congress. About six months ago the President selected him as a member of the Federal Farm Loan Board, and the act as you know it, has for its primary purpose the making available of credit to the landowner engaged in the cultivation of his farm to the same extent as the Federal Reserve Act broadened and extended the opportunity of credit to the merchant and to the manufacturer and to the man in other lines of business than farming. He is making good in the discharge of the important duties of that responsible position.

I now have the pleasure of presenting to you Hon. A. F. Lever of South Carolina.

ADDRESS OF HON. A. F. LEVER

MEMBER FEDERAL FARM LOAN BOARD

Mr. Chairman, Ladies and Gentlemen:

It has been of much value for me to sit with you in your sessions and an unbounded pleasure to come to the home of my distinguished friend, Congressman Small. I have known him twenty years; I have known him intimately; I have learned to appreciate his work, his broad vision work, more and more each day as I have known him.

Gentlemen, I have been astonished at the statement of what has been accomplished in the way of reclamation in North Carolina. I knew in a casual way, of course, that some work was being done in this State, but when the figures were presented that something over

600,000 acres of non-productive land had been reclaimed and put under the domination of man and made productive of the things that the human family need, I was absolutely astounded, and I was thinking last night that to have been the author of a statute under which that accomplishment was made, is a monument to the statesmanship of any man, and the people of North Carolina ought to be very proud of Congressman Small and those who helped him frame the drainage law of your State.

Mr. Ucker made a very interesting statement last night when he suggested to you some of the reasons for the apparent backwardness of the South, in some of these great movements. I have thought for some time that there are just three great reasons why we do not keep pace with other sections of the country in industry, agriculture, and economic development; and these three reasons might divide themselves about like this: First, the mosquito, the malaria-carrying mosquito. When a man from the North begins to investigate the proposition of buying these Southern lands, he is promptly met with the suggestion that when he goes south of the Potomac River he will die of some dreadful fever the next morning; that he is going into a land filled with swamps, with overhanging trees and mosses and mosquitos and malaria and death. If that does not get him, then the other story, the next handicap of the South, is promptly flashed across his vision; namely, that you have in the South an alien race, the negro and that there is bloodshed and riot and disorder and that every morning the white people eat a negro before breakfast as an appetizer; and of course you do not want to live among such people and under such conditions. Those are two things that have set the tide of immigration across the northern section of this country rather than into the southern section. These are the two things, coupled with the work of the transportation companies of that section of the country that settled the great states of Iowa, North and South Dakota, Minnesota, and made these great states, under the good farming practice of your Scandanavian farmer into the very great states of this Union. We are getting rid of the mosquito, we have got to get rid of it. The negro question is the bugaboo; we will solve that in our own way; we are solving it now. I think myself that it has been a great handicap to the South, but that is neither here nor there. You and I did not bring him here; we are not responsible for his being here; as patriots we have got to deal with the situation in good sense and in good charity; and we will do it. But there is a third reason which has handicapped the South and it is about this that I intend to address you more especially.

In 1860 there rang out across Charleston Harbor a boom that drove the roses from the cheeks of the women of the South and brought ashes to the lips of brave men. It was the opening gun in the bloodiest fratricidal strife that this world ever saw. It was the beginning of the settlement of a great constitutional question that could never have been settled except in blood and in tears. Thank God it is settled. And today, sixty years thereafter, we as equally in the South applaud the inspiring notes of "Yankee Doodle" as they in the North applaud the martial strains of "Dixie"; and it was the co-mingled strains of these two immortal tunes which inspired the blue at Gettysburg and the gray at Gettysburg to deeds of heroism that have not been approached in the annals of history, and it was to the co-mingled notes of these old martial tunes that the sons of the men who fought at Gettysburg in blue and in gray marched forward with the Stars and Stripes, always forward, from the bloody fields of Flanders to the very gates of Sedan. We have a united people once more. But that great struggle, my friends, set the South back just one half a century, industrially and financially. It was not until 1894 that the wealth of the South had assumed a figure equal to that of 1860. So that we have lost a full generation of effort in the period from 1860 to 1896; and it has been only since 1896 that we began to move forward without this handicap, and such progress as has been made within that time is unequalled in the history of this or any other country; and yet we are just beginning to see the rising of the sun.

Your third great handicap, therefore, has been a lack of money; a lack of finances; a lack of credit with which to develop the magnificent natural resources which you have in this section of the country. And this handicap rested heaviest upon your greatest industry, agriculture—farming. Prior to 1913 there was great demand for a reform of the currency system; for the building up of a financial system in this country which would respond to its economic and industrial needs; which would expand and contract as commerce and industry expanded and contracted; a system of finance which would be controlled by a disinterested umpire rather than controlled by a half a dozen, more or less, of men who were financially interested in the matter of credits. It is not too much to say, and I think you will agree with me, that it has been only within the last few years that the credit system of this country was not in the hands, absolutely, of a few of the great financial centers of the United States. The demand became so insistent that Congress applied itself to the task and evolved what is known as the Federal Reserve System, a system which does respond, automatically, either to the expansion of industries or

to the contraction of business. You hear a good deal of talk about preparedness—but it is my belief that the greatest piece of preparedness legislation that this country has ever seen was the passage of the Federal Reserve Act which controls the credit and the currency of the United States. It is my belief that this country could not have gone through the strain of the last five years under the old system of currency; it is my belief that the industries would have gone down in crashes; your banks would have failed and would have been facing ruin today, instead of a period of the greatest prosperity that has ever come upon our people. Without the Federal Reserve System we could not have mobilized as quickly as we did the resources of the country, its money, its industries, and without the quick mobilization of these we could not as quickly have mobilized the man-power of the United States which broke the backbone of Prussianism in this world war and did it so quickly and so well. But it was after the installation of the Federal Reserve System that the discovery was made that during all the history of this country, so far as legislation was concerned, national legislation, there had been no attempt whatever made to furnish any kind of credit to the greatest and most fundamental of all the industries of this country; namely, agriculture. The old national bank law prohibited a bank from loaning on land; John Smith, a farmer, would come to Washington, North Carolina; he would go into his bank and say, "I want to borrow a thousand dollars on five hundred acres of land five miles out of town." The banker would say, "I can't do it; the law won't allow me to do it. I'll tell you what I will do. If you go across the street and get Sam Jones, the merchant, to sign your note with you, I will loan you the money. I can't loan it on the land." Mr. Jones could die; he could go "busted", bankrupt; his little store could go up in ashes over night, but Mr. Smith's five hundred acres of land can neither blow away nor burn up and you cannot steal it. And yet the old financial law of this country said that you could loan money on the collateral of the signature of Mr. Sam Jones, but you couldn't loan on Mr. Bill Smith's five hundred acre farm which is producing enough products to give sufficient guarantee for the loan. Congress undertook to deal with that proposition. President Wilson in his inaugural address recommended such legislation. Mr. Small, Henry of Texas, Kitchin of North Carolina, Byrnes of South Carolina, myself, and others entered into conference after conference and everywhere urged the recognition of the right of agriculture to have such terms of credit as we are giving to commerce and industry. And out of this work two things were written into the Federal Reserve Act; first, the right of a national bank to loan money on farm lands for a period

not exceeding five years and up to a certain proportion of its assets. That was the first entering wedge; but more important than that was that portion of section 13 of the Federal Reserve Act which gives the member banks of the Federal Reserve System the power to re-discount a farmer's note based upon agricultural products when that note has attached to it a warehouse receipt, issued under competent authority.

Now, let us stop a moment, because I want to talk to you both about short time and long time credits. Let us not blame the banker for this; he is not to blame. Here is the man with a bale of cotton who drives it into town. He has had it sampled and graded and weighed. He is offered a price which he does not think is satisfactory. He does not want to sell it. He has to meet his obligation at the bank. You know money does not grow in banks. The banker gets his money from the depositor. He has to pay his debts, and if the farmer and merchant and lawyer and doctor do not pay their debts to him he cannot pay his debts to others. This farmer is not satisfied with the offér. He had no recourse under the old system except to sell his cotton. He has now. All he has to do is to take that bale of cotton to a warehouse which is bonded and under inspection, either state or federal or even private inspection; get a warehouse receipt, attach that warehouse receipt to his note, carry it to a member bank of the Federal Reserve System, have it rediscounted. That bank in turn will send it to the Federal Reserve Bank and get the money. This is a system of short time credit written into the Federal Reserve Act to take care of the proposition of moving the crops of this country at a period when banks have been unable to do it for lack of money. And under this system of rediscounting farmers' notes to which are attached competent warehouse receipts there is no reason in the world why farmer's crops should not be moved and moved promptly. Do you ever stop to think just how foolish we have been in the South in this matter? And we can see it in the other sections of the country. Our business is not different from theirs, except that they deal in cows and we deal in cotton. Labor is different; ours is black and theirs is white. What happens to cotton? I will tell you what I can do. I do not know whether hens have started laying around North Carolina or not. We will take a radius of five miles around the city of Washington, and we will get every egg that has been laid today in and about Washington. No shipping out now. Put them all on the market at Washington. We will break the price of eggs in the market fifteen cents a dozen. Why? Because you are dumping on the market, all at once, the products of flush production. Now that cotton which brings back to this country 28 per cent of all the gold that comes here: We are

marketing the bulk of that cotton over a period only of from September to December. We are selling most of our cotton crop in a period of four months, instead of over a period of nine or twelve months, with the result that you can take the figures and go back over twenty-five years and you will find that the price of cotton is always lower during these four months than any other months in the year. Why have we been doing it? Because we could not help it; that is all. We have been borrowing money to make our crop, which has forced us to sell our cotton prematurely. There are two things I want to urge today; one is that in this organization which you have to reclaim your lands, you are about to produce great crops; you are producing wonderful crops now on these reclaimed lands. It is your duty, since you have brought about such production, to see that you get the value of these crops by adopting the best methods of marketing, distributing and financing. And if you are to continue to finance and market them under the old system, then I am afraid your drainage work is like a lost song. I would like to see the power of your drainage organization and this North Carolina Landowners' Association and your pine lumber organization and every organization in the State of North Carolina which has a part in the upbuilding of this country get together and back of this great movement; to have in every section locally-owned, controlled and operated cotton, tobacco and other warehouses. When you have done that you will begin to walk in the paths of a genuine system of marketing. So far, you have had no system at all.

The most tragic figure in the world, to my mind, is a one or two-horse farmer who drives his bale of cotton into town, asks the man to sample it, weigh it, grade it and fix the price upon it. You will never have a voice in the fixing of prices until you have organized yourselves into financing and marketing associations something on the order of your drainage association, get together, exchange ideas, formulate plans, and with the elbow touch go forward to the accomplishment of your demands. I have been credited with being the author of the Agricultural Extension Act and it is frequently referred to as a great monument. I think so. But the greatest piece of legislation with which my name is associated is the Federal Warehouse Act, which intends to issue uniform warehouse receipts, which when attached to farmers' notes makes them eligible for rediscount under section 13 of the Federal Reserve Act. This supplies the machinery for the gradual marketing of farm products by giving the farmer the benefit of credits when he most needs them. I am not entirely responsible for it. No one man is entirely responsible for the idea underlying the warehouse act, but I believe twenty-five years hence when we, the

people of the South, wake up to the necessity of better warehousing, that through this work I will have brought into the pockets of the South more money than from any other act of mine in Congress. That is your short term credit proposition.

This five year proposition of long term credits on land is not enough, not liberal enough. The agricultural press, the leading thinkers of the country, said we must devise some plan of furnishing credit to the farmers that as nearly as possible equal in its efficiency the system which furnishes credit to industry and commerce. We cannot expect the farmer to take the chance of mortgaging his property, his land, and then not know whether or *not* at the end of the period of the mortgage he can get it renewed. We cannot afford any longer to ask agriculture to produce and to move forward under a handicap of an interest rate that averages on farm mortgages in the United States seven and a half per cent; from five and three tenths per cent in the New England States to six and seven per cent in the western and in the southern states to ten and twelve and a half per cent in Texas and the far western Rocky Mountain states. There is not an industry under high heaven that could prosper with that kind of an interest rate as a fixed charge against it. Folks began to think about it; began to look around and they said, "What is the trouble?" "What is the difficulty here?" "Why won't banks lend money to farmers?" I will tell you why they were not doing it. They were sensible. I would not have done it, except to help a mighty close friend. Suppose the banker tied up $50,000.00 for five years in a farm mortgage. Even if they did get seven and a half per cent for it the bank would go bankrupt the first year. Banks make money out of the quick turn-over of their money. It is the business of a bank to loan money on liquid assets, which sell themselves. Your note goes into the bank, which endorses and sells it, and keeps it going. That is how the banker makes his money. He would go into bankruptcy absolutely if he were to take the deposits of his customers or the stock of his stockholders and tie them up in these long time farm mortgages. He cannot afford to do that. I have never blamed the banker. So we had to find a way of taking this piece of land which is the best security in the world, and handling it in such a way as to give the farmer the money without crippling the bank. We had to find the machinery with which to do it. How did we do it? We studied the systems of farm finance of other countries. All the other countries of the world had done this. They had accumulated farm mortgages in great quantities in one big pool, as it were; they had issued bonds based thereon which they in turn sold to the public; and out of the proceeds of the sale of these bonds the farmer got his money.

We adopted that system, and when President Wilson in 1916 signed the Farm Loan Act, then and there began a new era in the history of American Agriculture. Because, for the first time since the founding of the goverment, the farmer is now enabled to borrow money upon his land at a rate of interest, so far, not exceeding five and a half per cent, and upon terms of annual repayment of thirty-four years. What is this system? Ten farmers get together in Washington County, North Carolina, bona fide farmers, or men who are about to become farmers. They make application for a charter; they get a charter. They want to borrow not less than $20,000.00 together. They become a corporation. They make application for their money to the Federal Land Bank at Columbia, South Carolina. The Loan in question is appraised by a local committee consisting of members of that association. It is further appraised by a Federal appraiser appointed by the Farm Loan Board at Washington, who is not interested except to get the real valuation of that land. His application is passed upon; his title is looked into. Sufficient security is proven and he gets his money. This system has been in operation only since 1917 and yet in that length of time there have been over four thousand of these farm loan associations organized in the United States, with 125,000 members, and through these associations to these farmers there have been loaned, when I left Washington the other day, $346,000,000 at five and a half per cent added over a period of thirty-four years. In addition to them, the Joint Stock Land Banks in the meantime had loaned $60,000,000 at one-half per cent added interest to quite a number of farmers, making a total loaned through this new system of financing agriculture of more than $400,000,000 in less than three years. There is not a parrallel in the history of the world that touches what has been accomplished by this system in the same length of time.

Now, let us see a little bit. The total farm indebtedness of the United States is five million dollars, more or less; more, possibly. This is a big sum of money that has been carrying an average rate of interest of seven and a half per cent. But, in addition to the seven and a half per cent, heretofore, the farm mortgage companies always exacted from one to three per cent commission to fix the loan; from one to three per cent, depending upon the section of the country and the demand for money. Then, when your mortgage expired at the end of five years (that is the average), they required another commission of from one to three per cent to get it renewed, if you got it renewed at all. So that the farmer was paying anywhere from seven and a half to ten and a half per cent on the average for his money in this country. There is no other industry in the United States on which you are asked to pay

that rate for money. That is what you were buying money at. But that was not the worst of the situation. In many sections of the country the little farmer who wanted to borrow five hundred or two thousand dollars could not get it at any price. The money lender said, "I do not want to fool with it; it is too little to bother with; it won't pay." And yet down here in the Louisiana Land Bank the average of the loan in the district is only fifteen hundred dollars, and they are loaning money in that district to negro farmers, as little in amount as two hundred dollars, on his little farm. And they have negro settlements down there that they have built up with the aid of the progressive white men where they are making such progress as to warrant great agricultural journals sending men to write them up. The act was intended to take care of the little farmer. The big one can take care of his own financing. This act was to enable the average farmer to pool his credit and upon that pool get the money. And we have done it beautifully.

There are a good many things the matter in this country. In 1880 only 28 per cent of the people of this country lived in cities and towns. Now my own judgment is that your census figures for this year will show that over 50 per cent live in towns and cities. Who is going to produce the things that the human family must have? I can do without an automobile; I can do without a fine house; I can do without many things; but there are a few things I cannot get along without and of these we might mention clothing, fuel and food as being absolutely essential to the maintenance of life itself, and if this constant draining of the farms of their labor by the towns and cities keeps on some one is going to go hungry and that, too not in the very distant future. That is plain talk. There is just one class of people in this country that the world cannot afford to let go on strike and that is the fellow who pulls the bell cord over the mule from day to day. And it must be a source of extreme gratification to you men of the farm to think that during these days of strange thinking and stranger acting the American farmer has not lost his balance. He is standing true to the traditions and the institutions of his country.

What is the matter with the situation on the farm? Why are the people leaving? That is the biggest problem in America today. It is bigger than any other problem confronting us. What is the matter? Why should the young man or boy turn his back upon the scenes of his childhood, say good-bye to the farm and friends and go among strangers and seek a living in a strange land? There must be something back of it. We do not leave the pleasant recollections of our childhood except for a cause, and it is usually because we think we will find an opportunity to better our condition in life; that is why we leave. Do you

blame the country boy or girl from leaving a community where you are paying your school teacher not over four hundred dollars a year? Do you expect the far-seeing young man who intends ultimately to become the head of a family to want to stay and make his home where you have that kind of educational facilities; or where your preacher is getting fifty dollars a month, maybe? And where, if you want to go and see your sweetheart, if it happens to rain the evening before, you must wade knee-deep in the mud to get there? Of course he is not going to stay. Do you expect the farm wife, my friends, to be satisfied day in and day out; in hot weather and in cold; in sunshine and in rain, to get out of bed at four o'clock every morning, prepare the children for school, prepare breakfast for the household and a gang of workmen, and do the million and one other things the average farm wife is expected to do, without any convenience in the farm home? Not one farmhouse in ten in the great progressive State of North Carolina has running water in it. Not one farmhouse in twenty in North Carolina has artificial lighting in it. It is not the farm man who is so dissatisfied with the farm conditions. If things don't go right with him; if the hogs break through and get into the corn; if the fence blows down and the cows get into the cotton, and he feels blue about it—he jumps into his Ford and goes to town, gets in a good humor, after a smoke or two and a round or two of talking politics—and comes back home. It is not so with the farm wife. No matter if she does burn the biscuits, if the rope does break and down goes the bucket in the well; she has got to stay there from the rising to the setting of the sun, three hundred and sixty-five days in the year. She is the most pathetic figure in the world, God bless her.

And I want to make my appeal to you men of North Carolina. Forget your automobiles for a while; forget your own comforts for a while and instead of getting a Ford, take the whole business and put running water and acetyline lights in your home. That is the kind of doctrine I like to teach and I believe it strikes a responsive chord in the hearts of men like you. But, all these things cannot be done without money. One of the greatest troubles in the South has been that we have given too little brain and too much muscle to agriculture. Any fool can plow a mule, but it takes both money and some skill to run a tractor; you cannot have this drainage which you speak of and which is so absolutely essential to the farm practice; you cannot put in silos which are essential to stock farming; you cannot build up-to-date fences; you cannot paint your home; you cannot put in these conveniences for your wife and children without money. You cannot put music in your parlor. You cannot educate your boys and girls unless

you have money, and under the old system a man could not afford to mortgage his little home even to send his boy and girl to college. He certainly could not afford to mortgage it to put lights and water in the home, because he never knew whether it was possible to renew the mortgage at the end of the renewal period.

I can remember my father, my friends, during the panic of 1893. I was just a boy; my mother died when I was five months old. The panic was on; the mortgage was to be due in the next month or so. I can remember him during the night walking the floor, groaning, like a man in anguish. And that was true of hundreds and thousands of good men throughout the country. The Farm Loan System opens to you who take advantage of it, who come into it, the opportunity to get money at five and a half per cent; you add one per cent to that, six and a half per cent in all, and that covering a period of thirty-four years will pay the loan, interest and all. A man in that kind of a system can afford to go into debt. I would not tell you to go into debt under the old system; I know what it means. I can tell you to go into it under a system which gives you that kind of terms. So long as you pay your interest, the law which was written by men who knew the farm problems, guarantees to you that the mortgage cannot be foreclosed. If an unfortunate year comes along, there is an authorization for a deposit of six million dollars to take care of any unfortunate circumstances.

Let me close by saying this: An organization such as you have can be of tremendous influence in spreading this information for the betterment of rural conditions. I venture to observe that not twenty-five per cent of the farmers of North Carolina ever heard of the system and what it is doing and has done. I was talking to the editor of one of the great finance journals of New York some time ago. I told him about this system and he said: "What is that?" I was not surprised. I took him down and had the gentleman at the bank in Columbia show him the whole system. He said he was ashamed to admit it, that though he had seen something about it in the past he had forgotten that there was such an act.

I was passing through the city of New York a few weeks ago to deliver an address before the Agricultural Society of the State of New York, and as I went through the crowded streets and saw men and women rushing helter-skelter, and as I went up 35th Street and saw the heads of little children and old women watching the train go by, I thought how many of them had any appreciation or knowledge at all of the source from which they got that which keeps life and body together.

Whose problem is this? Is it your problem? Who is it that is interested in the development of North Carolina? Is it you farmers only? Who is it that is interested in the upbuilding of the rural school system of North Carolina? Is it you out in the country? Who is interested in the live stock industry in North Carolina? Is it you who handle the cattle out in the country? Who is interested in the campaign to clean up the cattle tick in this State? Just you who are going to grow the cattle? Who is it that is interested in holding up their hands as a bulwark against the onrushing tide of immigration from the country to the towns and cities? Whose problem is that? Who is it that would like to see agriculture financed on terms of decency? Whose problem is that? Are you, only, interested in that?

Here is a convention representative of one of the great progressive movements in this State, under whose leadership hundreds of millions of acres of now wet lands are being converted into instrumentalities of wealth and happiness and their benefits are not for the farmer alone, but for every class of society. Is it your problem alone? Oh, no, my friends. I sometimes wish that I had the opportunity to gather together every merchant, every banker, and every manufacturer in the states of North Carolina and South Carolina, lock the doors and inject into them a good dose of strychnine to make their heart action good and strong so that I might tell them that the problem of the farmer is their problem and that it is up to them to lend their vision and their observation and their leadership to these great movements which are for the betterment of the agricultural life of these States.

TILE DRAINAGE OF FLAT LANDS

BY F. O. BARTELL, Drainage Engineer,
Office of Drainage Investigations, U. S. Department of Agriculture

Mr. President and Gentlemen:

The Eastern Coastal Plain of North Carolina contains thousands of acres of land so flat and deficient in natural drainage as to produce only a small fraction of the crop that its natural fertility would warrant. Large areas of the wettest portions, as of the great swamps, pocosons, and "flat piney woods" have never been touched with the plow. Other portions, depending upon natural surface conditions of slope and of soil, are to be found in various degrees of cultivation. In practically all cases, the slopes are too slight to permit the water to escape fast enough for good drainage, and large quantities soak into the ground and bring the water table to within a few inches of the surface or stand until removed by evaporation. Even in those parts under cultivation, the standard of drainage is low, and great risks are run in the growing

of crops susceptible to moisture, with very real losses in the wet years, though every advantage of thorough cultivation and fertilization be given. The fact that these losses are due to excessive moisture in the soil is shown by the fact that in "dry" years almost without exception, heavy yields occur. It seems, then, that it would be "good business" for the farmer to *insure* his crops against the wet years, and the logical way to do this is by some form of artificial drainage whereby all years may be turned into dry years.

We insure our buildings against fire and wind, our automobiles and valuables against theft, our ships and their contents against the force of the elements at sea, we have health insurance, accident insurance, insurance against the possible injury of those in our employ; (some of the lucky ones here are possibly insured against a long dry spell and I am going to look them up after this meeting is over). The insurance agent goeth through the land "like a roaring lion seeking whom he may devour." He is a pest, but we admit it is a good business proposition.

We even have hail insurance on our crops. Gentlemen, why not insure our crops against the one great factor that makes farming in this Eastern Coastal Plain section a gamble instead of the legitimate, safe, business proposition it should be? Should a farmer wager his time, his money and the efforts he has given in planting and cultivating his crops against the chance that the single heavy rain necessary to ruin them will not come? Thorough drainage will remove this uncertainty, will insure his crop. The premiums we pay will be the interest on the investment in the drainage systems; the dividends it will pay are the increased returns in our crops.

I have said that the present standard of drainage is low. It is accomplished by a network of small farm drains emptying into open collecting ditches which in turn pass their water on to large main canals that lead into natural channels or tidewater. The large main canals are spaced generally a mile apart; in some cases one-half mile apart; there is no standard spacing for the collecting ditches, and the open farm drains are spaced from a maximum of 110 to a minimum of about 55 yards apart, depending upon the character of the soil. I recently made a survey of some land near Aurora where the drains were spaced about 55 yards apart and found that of the 267 acres of land surveyed, 40 acres or 15% was taken up in ditches and lost to cultivation. These farmers howl like mischief when Uncle Sam hits them for 4% on the income tax, yet here is a drain on their pockets of 15%. This system of drainage is inefficient, much land is lost to cultivation in the land occupied by the ditches, their banks grow up in weeds and briars, and furnish harboring places for the insects and

plant diseases that are such a nuisance in this country; they require periodical cleaning out and shrubbing of their banks, do not admit the use of modern machinery in the cultivation of crops (and this is an important factor now with the present shortage and inefficiency of labor) require expensive bridges which must be maintained; and, in short, is not only inefficient in itself but leads to inefficient and costly methods of working the land.

In contrast to this, let me enumerate some of the advantages of tile drainage, because it is deeper drainage as a rule, and because it lets air into the soil and disintegrates it so that the water will pass down through it easier. Because it gives deeper drainage, it allows the plant roots to go deeper into the soil, protecting them from heat in case of dry weather and hence makes the plants more resistent to drought. Since the roots go deeper, it allows the plant to obtain food from a source it did not have before and opens up a new form for it to feed upon. Because it lets air into the soil, it loosens it so that tillage is easier and lets the water off more quickly so the land may be cultivated sooner after a rain. (Early in 1918 a farmer in Pitt County tile drained a 30-acre field. Two very heavy rains in a week fell on this piece a year ago last June, the second an 8-inch rain. Three days after the second rain, he was working that field with every man and mule available, while it was 10 days after that rain before he was able to cultivate any of his other fields, a saving due to tile drainage for *one* rain of a week's time.) The land is also ready for cultivation earlier in the spring, and plants will get an earlier start for the soil is drier and more easily warmed by the sun than if it were more wet. It eliminates the nuisance of so many open ditches and keeps the fertilizer on the soil instead of floating it off down the ditch.

As the insurance agent would say, "Can we afford *not* to tile drain?" But I will speak on the cost of tiling later.

Tile drainage of flat lands differs in several important ways from that where the ground is rolling. In the latter case, there is generally a good outlet into some natural ravine; soil conditions are different; we have, as a rule, good fall and can get any depth we desire. The water collects in ponds or in draws through which only a few random lines of tile need be run to get good drainage. In flat lands, however, we have no natural outlets, but obtain them by dredging deep canals. The depth to which we may put our tile is limited by the depth of the outlet. Fall to the tile must be obtained by digging deeper toward the lower ends, and is also limited by the depth of the outlet canals; soil conditions are more varied and

require much experience and judgment in regard to the proper depth, spacing and grades necessary. The question of limiting sizes of tile arises and must be studied in respect to value of the land and cost of maintenance of open ditches. Do we need surface relief ditches or will surface water inlets into the tile lines answer this purpose? Many problems arise which must be given close study and consideration. Some of these we are able to answer now; others must be left to the future for solution.

Upon the character of the soil depends the entire design of the drainage system, modified, of course, by topographical conditions. The soils of eastern North Carolina vary greatly as respects porosity and it is upon this characteristic that the proper relation of spacing and depth of the laterals depends. In general, it is true that the more open the soil, the further apart and deeper can the laterals be placed. Our observations indicate that the beneficial effect of depth increases in the more open soils up to a depth of five or six feet. On the tighter soils, better results will be obtained by depths of from 3 to 3½ feet. It is my opinion that in no soil should the tile be laid less than 3 feet deep. Proper depth is all important and should be determined by careful study of each type of soil encountered. Muck soils, especially, require considerable depth to the tile lines. This type of soil shrinks to a very appreciable depth when drained, and the vegetable matter of which it is comprised is decomposed by the admission of air due to drainage. Allowance must be made for this shrinkage. Again, the muck itself furnishes a poor foundation for the tile, which should be deep enough to rest in the more substantial subsoil below.

The character of the soil also determines, with the depth, the spacing required, and this varies considerably in different types of soil and in the same soil under different conditions. For example, a muck soil when first drained can be tiled with a very wide spacing between laterals. As the soil settles, it decomposes, and becomes more firm, a closer spacing is required. On the State Test Farm at Wenona, tile lines 330 feet apart are giving very satisfactory drainage, but ultimately, this spacing must be reduced. The sandy loam soils, as a rule, are thoroughly drained with a spacing of about 100 feet between laterals. Systems may be installed in new ground with a wide spacing between laterals with a view of adding additional laterals as the soil becomes more compact.

In flat lands, the character of the soil rather than the topography should govern the grades given the tile lines. In sandy soils and sandy loam soils, more or less fine material finds its way through the joints

into the tile, and the grades must be such as to give a velocity sufficient to carry this to the outlet; otherwise, the tile will fill with silt. Much trouble and several failures of tile drainage systems have occured in eastern North Carolina due to lack of appreciation of this feature. In clay soils, free from sand, this consideration is unimportant, as also in muck soils underlain by a clay subsoil. In these soils, tile can be laid on very flat grades and give excellent results. On the Test Farm at Wenona, long laterals laid on a grade of three-fouths inch fall in 100 feet have been in for several years and are entirely free from silt, although it was impossible to keep a considerable amount of muck from entering them during construction. This material seems to be light enough to wash out readily on the flat grade. In clay soils free from sand, the tile can generally be kept clean during construction and when once properly installed, there is almost no danger of the clay entering the tile and it will likewise operate successfully on very light fall.

Cases where silting has occurred seem to be in the very fine or fine sandy loam types of soil and investigations indicate that in these types of soil great attention must be given to giving proper grades. In most cases, a velocity of 0.7 feet per second seems to be sufficient to keep the tile clear of sediment; in others, a greater velocity was necessary to keep the tile entirely free from silt. A velocity of 0.8 feet per second seemed to be sufficient in all cases observed to keep the tile clear. The following table gives the fall required for different sizes of pipe to give these velocities.

MINIMUM GRADES FOR TILE IN FEET PER HUNDRED

Size tile:	4 inch:	5 inch:	6 inch:	8 inch:	10 inch:	12 inch
Velocity 0.7 Ft. sec.:	0.22	0.16:	0.12:	0.08:	0.06:	0.04
Velocity 0.8 Ft. sec:	0.28	0.21:	0.15:	0.10:	0.07:	0.05

Where these grades cannot be obtained, it becomes necessary to wrap the joints of the tile in order to keep out the silt. Burlap, roofing, tar and building paper have been used successfully for this purpose. Straw and other materials packed about the tile in the trench have been used with varying degrees of success and more information along this line is necessary before definite recommendations can be given.

It is evident that with the light grades and their careful application necessary in the design and installation of tile drainage systems in

flat lands, that this is a strictly engineering problem, and only the employment of a conscientious and competent engineer together with careful workmanship will insure the success of the system.

A study of the table shows that for the small laterals in a system more fall will be required than for the mains. Economy in design requires the use of long laterals and short mains. In flat lands where the depth of outlet is generally limited, and the slope of the surface is small, it is necessary to reverse this rule and design the system with short laterals and long mains to decrease depth. The purpose of the tile main is to carry the water from the laterals to the outlet. Its depth is determined by the depth of the laterals at their outlets, and by its length and the fall that must be given it. It must empty either into some natural outlet or into an artificial open canal. In flat lands an artificial canal must almost invariably be provided as this outlet and the depth of this canal must be such as to provide a free outlet to the tile under average conditions. Mr. Lynde has discussed the depth and spacing necessary for these canals in his paper.

It should be the aim in the drainage of these flat lands to do away with all open ditches except these main canals. A little thought will show the advantages of such a plan. In the Middle West this is an actual condition, and there they lay tile up to 42 inches in diameter to keep from having these open ditches. The use of large tile is economical, contrary to popular opinion, even among engineers in this State. For instance, in a recent investigation by our office of the drainage of a large farm in the Moyock District, it was found to be a decided economy to use tile up to 21 inches in diameter over an open ditch. To compare the cost of an open ditch system as commonly practiced in this state with that of a tile system, with a spacing in each case of 330 feet between laterals, I have prepared an estimate of the cost of each with the following results for present prices of material and labor. The area of the tract, assumed to be flat, was taken as 80 acres.

Estimated cost of tile drainage system (Using tile up to and including 14 inches in diameter with a minimum depth of 4 feet.)	$2,340
13,200 feet open ditch at 9c per linear foot. (3 feet deep, 2 feet wide at 40c per cu. yd.)	1,190
Difference in cost in favor of open ditch system	$1,150

With 12 feet lost to cultivation in each open ditch, we have 3.64 acres or 4½ per cent of the area. The value of the land lost, at

$100 per acre, is $364. $1,150 minus $364 is $786. Net cost of tile system over open ditch system or $9.83 per acre. The yearly cost of clearing the open ditches at 2c per foot is $264, or $3.30 per acre. $9.83 divided by $3.30 is 3.0, or three clearings would pay the difference in the cost of the tile system over the open ditch system. The first year the ditches would require no cleaning, so that in four years, the tile system will have paid for itself in this item alone, not considering the saving in decreased cost of cultivation, the increase in crops due to better drainage, cost of bridges and other numerous advantages. After the first four years the annual saving in the cost of cleaning amounts to over 11% on the cost of the investment—a rather profitable investment.

In my opinion, such a system will give far better drainage than the open ditch system it replaces. Some engineers contend that the tile system would need to be supplemented by a system of shallow surface ditches to allow for surface run-off. In my opinion, this can be fully provided for by surface water inlets directly into the tile, but should the relief ditches be necessary, their added expense would be small, and they can be made wide and shallow and be cultivated with the rest of the land.

The use of tile, then, gentlemen, in draining the flat lands of eastern North Carolina is practical and economical. As a means of improving farming and health conditions, it has no equal; as an investment, it cannot be surpassed. I foresee the time, and it is not far distant, when this land will be, as is the prairie land of the Middle West, one vast, uninterrupted field of growing crops, broken only by large main canals from ½ to 1 mile apart; when the farmer will start in plowing with his tractor at one end of the furrow in the morning and return on the next to his starting place at night; a land of health and wealth and beauty; that will give added lustre to the great name of Carolina.

In conclusion, gentlemen, I will say that I have always wanted to get up and speak before a Drainage Convention. It has been one of my ambitions, like singing. I like to sing. It always has been a source of great satisfaction to me that I sang in a choir once. That's right: *once.* When they found out what was really the matter with the choir, I didn't sing any more. In like manner, it will always be a great source of satisfaction to me to have been able to address this Convention *once,* and I thank you for the opportunity and for your attention.

Just before the close of the morning session there were some interesting reports made on drainage districts of both the Piedmont and Coastal Plain regions, the following taking part in these reports: W. D. Alexander of Charlotte; W. K. Allen of Wilmington; C. W. Mengel of Belhaven; J. I. Herritage of Jacksonville: P. H. Johnson of Pantego; Pat Matthews of Edenton, and John F. Latham of Bath.

PIEDMONT DRAINAGE IN NORTH CAROLINA

BY W. D. ALEXANDER, Drainage Engineer

Mr. President:

In talking about drainage in the Piedmont Section, it is best to say in the beginning that, owing to the rolling nature of the country, we have no such wide expanses of swamp as are found in this part of the State. On the contrary, the hills prevent the swamps from spreading far beyond the streams that originate them.

Between these hills and bordering on the streams lies a narrow, rich valley, which is the original corn growing land of the adjoining farms. The clearing-up and washing-away of the slopes have caused the channel of the winding stream to become so filled with sand that it no longer drains these bottom lands and no longer permits them to be tilled.

When the filling-up process begins these streams are so subject to overflow that the landowner does not consider it safe to plant the bottoms. So he lets them grow meadow grass which he mows for hay. Soon wet places appear in the meadow, over which the machinery cannot run, and in these wet spots willows flourish, they and their congenial soil rapidly spreading until the once fruitful meadow is an abandoned swamp.

To reclaim this land requires the cutting of a new channel for the stream. This channel must be deep enough to properly drain the low parts of the bottom and large enough to carry off the rains without flooding the bottom, also of such width as to prevent the settling of large quantities of sand that will inevitably get into the new channel.

The worst enemy we have in our ditches is sand. The heavy rains that fall on the hillsides wash the lands and carry large quantities of sand into the channels of the streams. We engineers tell the landowners they should keep the sand out of the streams. This they try to do by terracing and deep plowing but it seems impossible for them to keep it all out. To keep sand from settling the channel should be narrow in the bottom, thus giving weight to the water so the sand will keep rolling.

We are now working on about thirty different districts in North Carolina, South Carolina and Georgia. These districts average from seventy to a hundred acres of bottom land to the mile of new ditch—the larger the stream, the wider the bottoms. The cost per acre for the main channel of the creek runs as high as $73.00. Futhermore, the lands must be cleared and hand-ditched which will run the cost up to between $100 and $150 per acre before a crop can be planted. On such propositions as these, it is a difficult matter to sell bonds at par. Therefore, we recommend to the landowners that each pay his assessment in cash and have the district free from the burden of bonds. This is by far the most satisfactory way to raise the money to pay for the work. With all farm products bringing the present high prices, the farmers have plenty of money. Furthermore, it is a psychological fact that when the landowners have paid their dredging bills they are much more satisfied with the ditch than if they have regular assessments to meet each year. I have one district where every cent was paid in cash, and the assessment was over fifty dollars an acre. However, most of the districts have unsettled estates, or someone who is not financially able to pay cash and bonds are issued for the small amount and handled locally.

At this time bonds are hard to sell, for the simple reason that so many are on the market. Would it not be a good proposition for all districts to pay cash instead of being bonded? This is a good time to pay debts but a bad time to make them. Cotton is forty cents a pound and labor proportionately high. Ten years from now cotton may be twenty cents a pound. We contract for bonds when money is cheap and pay when money is high. The same principle applies to road bonds. Why not levy a tax to build good roads and pay for the high priced work while high prices can be gotten for produce?

The high prices paid for drainage at this time is a paying investment to landowners. A farmer can raise four times as much corn on his reclaimed bottom lands as he can on his upland, and with the same amount of work. I have heard numbers of landowners say they would not have their lands as they were before dredging for twice the cost. I have also heard numbers say they had made enough on the first year's crop to pay all the expenses of dredging.

Often, after a district has been ditched, farmers on nearby streams see the benefit and organize a district of lands that are in cultivation. They realize that nature has not cut the channels sufficiently deep and straight and that their tillable acres will soon grow up in willows and be abandoned, unless the slowly-filling channels are dredged. The neglected swamp brush also entails much labor in clearing, which

those wise farmers avoid who ditch while their fields are still open.

Every creek and small river in the Piedmont section is a good prospect for a drainage district. All that is necessary to get it organized is to show some influential and progressive farmers the benefits his land and his neighbors' land will derive from drainage, give him Form Book No. 38, a lawyer and a drainage engineer and the stream will be drained.

DRAINAGE PROJECTS

PAT MATTHEWS, Drainage Engineer

Perhaps very few people living in the great Cities of the East are aware of the vast area of land almost at their doors, still in a virgin state.

These lands mean more to them than they can imagine, for it is to them, they will soon have to look to, for a great part of the necessities of life.

Cities like New York, Boston, Philadelphia, Washington and Baltimore, with their enormous populations, and still "increasing at an enormous rate," for they increase in population to the squares of their diameters, will soon, and even now require more food and clothing, than the railroads can carry on a long haul.

There are millions of acres of the finest lands in the world, lying idle, ready to be reclaimed within forty-eight hours haul, but strange to say, almost no effort has been made to make them productive and ready for the settlers. Thousands of strangers from this and foreign lands, have come to our eastern seaports and gone west, passing over acres of diamonds and gold to settle on lands not so good, either as to climate or fertility. Lands that will only grow one crop a year, when the lands of Eastern North Carolina will produce two or three crops, if proper rotation is adopted.

The greatest menace to the world today is the great influx to the towns, and instead of trying to stop it, and keep the people in the country, the cry is boom this town and boom that town, make greater this city and that city, until the day has actually arrived when a near supply of food must be procured to stave off unrest and starvation. Most of these towns are within two weeks of starvation now.

In order to develop these fine lands, money must be found, and it is the rich of those cities that ought to supply it to save themselves. The trouble is they know nothing about such matters. Therefore, they would rather invest their money in building cotton mills, manufacturing plants of all kinds and in building up towns generally, not giving a thought of where the raw material can be produced. If this

condition of things goes on the plants will become junk and their money gone forever. But if they invest in the development of land and make it ready for the plough they will not only get big returns but will continue to do so. The lands will always be there and cannot be destroyed. I suggest that this Association take ways and means to interest capital in this direction.

Afternoon Session

PROF. M. E. SHERWIN, Presiding

At the afternoon session some most interesting talks were made on the results of drainage of the swamp lands in Eastern North Carolina by R. K. Smith, Vice-President of the Norfolk Southern Land Company; J. E. Shepardson, General Manager, Potter Farms; P. H. Johnson, President and General Manager, Albemarle Farms, and Mr. Wm. G. Benham of the North Carolina Farms Company.

POTTER FARMS

BY J. E. SHEPARDSON, Gen'l Mgr., Potter Farms, Inc., Belhaven, N. C.

Potter Farms, Inc., a tract of 42,000 acres of heavily timbered, black deep soil bottom land, located in Washington and Beaufort counties, in Eastern North Carolina, between the Albemarle and Pamlico sounds, has been undergoing agricultural development since 1916.

Location.—This property, between the older agricultural developments of Terra Ceia on the southwest and Wenona on the east, lies west of, and adjoins the Mackeys-Belhaven branch of the Norfolk Southern Railroad for a distance of fourteen miles, extending 5 to 6 miles back therefrom.

Soil.—The Farms are situated in what was formerly a shallow sound or land-locked basin in which has been deposited a blanket, two to eight feet in depth, of loose, porous, crumblike muck, rich in humus and available plant food. Of a total of 105 test holes to determine the character of the soil in the entire tract, eight holes under two feet gave an average depth of 1.7 feet of rich black surface soil, 46 holes 2 to 4 feet depth similarly gave an average of 3.6 feet of surface soil and 51 holes 4 to 8 feet depth gave an average of 5.6 feet of surface soil. The average of all holes gave a depth of 4.5 feet of muck or rich black surface soil.

Timber.—The area is generally covered with a heavy tree growth of gum, maple, juniper and scattering pine and cypress, considerable portions of which have been logged over several times during the past century.

Drainage.—With a surface elevation from 12 to 25 feet above sea level which is 6 miles distant and a surface slope approximately one foot per mile, the land lends itself particularly well to effective drainage by gravity flow.

A dividing ridge separates the drainage, the northernly 16,000 acres finding an outlet into Albemarle Sound and the southernly 26,000 acres, which has been formed into the Albemarle Drainage District, having its outlet into Cuckolds Creek, a tidal stream finally discharging into Pamlico Sound.

Albemarle Drainage District.—The Albemarle Drainage District organized June, 1917, comprises 30,000 acres, of which 26,000 is Potter Farms land. The drainage canals consist of an outfall canal 5 miles long, with 38 feet bottom width and an average depth 8.5 feet, connecting Cuckolds Creek at sea level with the main intersecting canal, which, adjoining the Norfolk Southern Railroad, extends along the eastern side of the district its entire length. The cross section of the main intersecting canal varies, the average depth of same being 8.5 feet. Extending westward from the main intersecting canal, at approximately right angles thereto, the plans call for 18 parallel lateral canals one-half mile apart, extending to Long Acre Ridge on the west side of the drainage district, a varying distance of five to six miles. Some omissions of parts of the above laterals in the northern part of the district are now contemplated.

The cross section of the lateral canals have 14 feet bottom width, 21 feet top width and 7 foot average depth, a size of cross section twice that necessary for drainage requirements but required to accommodate a floating dredge with machinery powerful enough to handle the logs and stumps on the canal right-of-way.

Two and three dredges have been operating since 1916 and with 75% of the work completed, the dredging should be finished early in 1921. The machines employed are the "American Steel" floating dredge, with 1½ yd. dipper, 40 and 45 ft. boom, carried on hulls 14 and 16 ft. wide.

Development Work.—The method pursued in the agricultural development work, after the canals are dug, is similar to that carried on it the adjoining projects during the past eight years, and consists of digging open ditches and cutting down and clearing the timber. The ditches, dug by hand, extending from one half-mile canal to another, are 3 feet wide, 4 feet deep at the canal and 2½ feet midway between. They are spaced 660 feet apart or eight per mile but eventually the 660 foot interval will be split and tiling will take the place of the open ditches. Ditching proceeds throughout the year.

Beginning July 1st, with the vegetation in full leaf, the cutting contractors begin work, continuing their operations to the February following. With axe and saw the tree growth is cut, generally leaving only the larger cypress trees standing because of their timber value. The cutting is designed to cover the land with one vast brush pile, the 1919-20 cutting exceeding 1,600 acres in extent.

In early May, following the cutting, the area is burned over, immediately after which corn is planted among the partially consumed logs and stumps by the "stuck corn" method.

The burn secures several results, namely:

(a) Destroys the weeds and bush growth.

(b) Burns all brush and smaller logs and partially consumes the larger logs and stumps.

(c) Leaves a heavy deposit of ash, thereby supplying calcium carbonate and potash to the soil.

With a good burn, much of the growing weeds and the weed seed bed have been consumed, and owing to the loose, porous texture of the soil, satisfactory crops are gathered in the autumn from considerable acres, which require no cultivation whatever from the time of planting.

Sticking the corn is performed by men, women and children in groups of ten to fifteen, each person provided with a sack of corn and a pointed stick. The stick is jabbed into the warm, moist soil, two kernels of corn dropped into the hole, the stick following the corn to wedge same into the soil, a step forward and the operation is repeated.

The corn is gathered and carried to the ditch banks, from where it is removed by carts to the cribs.

With the corn in the crib, the stalks are cut and the May following, the second burn occurs. Owing to the subsidence of the soil from 6 to 18 inches, the fire has free access to the roots, and burning the same; the stump is likewise consumed. Neither the stump pullers nor explosives are used in the clearing operations of the muck lands, nature and the fire taking care of the situation. With burning and cropping for three and four years, the stumps and remaining logs can then be piled and burned leaving all further operations of preparing for and planting the crop to be handled by machine methods.

The ash from the successive burns, with its calcium carbonate and potassium elements, is returned to the soil and makes expenditure for fertilizer unnecessary for a number of years following.

While the muck soil is adaptable for crops of all kinds, excepting perhaps tobacco, corn is the most easily handled crop during the period of reducing the land from its original timber state.

Broad Acre Ranch.—To establish the great value of this section for hog raising and to serve as an experimental and demonstration farm, the interest owning Potter Farms have a 2,000 acre operation, under development since 1916 at Broad Acre Ranch, devoted to raising registered Duroc-Jersey Hogs. The herd in 1919 comprised 1,500 hogs in various stages of growth and development.

Development Organization.—A development and operating organization, with headquarters at Belhaven, clears and operates lands for the company and for purchasers on a cost plus basis.

Beginning August 1917, this department has approximately 4,000 acres ready for corn planting this spring, of which 700 acres, jungle thirty months ago, is now piled for the final burn, following which, the ground preparation and planting will be handled by machinery.

The rate of progress of the development is now limited only by the supply of efficient labor in sufficient quantity at reasonable cost. With more than 40,000 acres of recently developed new lands adjoining now on an operating basis, and with several other reclamation projects in the immediate section, all demanding ever increasing amounts of labor, the local labor surplus is exhausted and additional labor from new sources of supply must be secured.

Class of Purchasers.—The rich bottom lands of eastern North Carolina make strong appeal to the man familiar with corn and hogs, and the bulk of Potter Farms sales so far made have been to prosperous farmers of the middle west, where, with present farm values from $200 to $500 per acre, the Carolina situation by comparison seems especially attractive.

With a two months longer growing season, green pastures throughout the year, greater yields of corn and hogs and higher market prices for the same, with the better climatic conditions of the coastal country and much lower prices of farm lands, the middle west farmer finds many convincing reasons for investing in and moving to this section.

MAINTENANCE OF DRAINAGE DITCHES

BY W. K. ALLEN, Drainage Engineer

I have been asked to make a few remarks on ditch maintenance work, and I do not wish it to appear that I am trying to back away from the subject, but must say that an intelligent discussion of maintenance work cannot be made without much reference to construction. However, all ditches, no matter with what careful and apt plans by which they have been constructed, will need some attention, especially while the ditch is in its new stage, or I should say during a period of

from one to two years in which the natural settling of the waste banks, and the crumbling away of the broken top banks will require to become solid and settled; and also the perfectly constructed ditch, will constantly need a small amount of attention in rectifying the damages accruing from the natural causes of nature.

As to the close relationship of construction with maintenance, I will say that the first step in maintenance work to be given all ditches is proper construction, or before construction I should say, the original plans for the construction, which will require a careful study of the nature of the soils where the ditch is located; the grades that will have to be conformed to in the bottom lines of the ditch, as well as their side slopes, together with the dimensions. The usual plans in use in our coastal districts provide for a side slope to the ditch of from one-half to one, to one and a half, which is as nearly correct as any uniform design we can adopt for this section. The general nature of the soils composing our swamp lands being very loose and porous are not subject to any great amount of caving. The period of time in which these ditches will need the most care is for the first year after their construction. During this time the greater portion of stumps and roots loosened by the machine in cutting the ditch will have decayed, and the loose earth around them given way and the soil composing the waste banks, berms, and side slopes will have become compact and assumed their natural form. The filling in of the ditch from these sources will be about over at this stage, which I consider the most important for maintenance work. For these matters which have eroded into the ditches should be removed without delay, for where these loosened stumps go into the ditch and the unsettled earth from the waste banks, and sides have been washed in by the weathering actions of water and freezings and seepings through the banks until they have become settled and solid, will fill in the ditch bottoms, and especially where these loose stumps have gone in, which, if left there, will become imbedded in the sand and mud; and, not only incapacitate the ditch for its designed purpose, but the longer they are left there the more difficult and expensive it will be to remove them, and the sand bars formed around these obstructions will destroy the grade to the ditch bottom, and this bottom grade is just as essential to the efficiency of the ditch, as it is to keep the ruts out of a public highway, and the great disadvantage the ditch bottom has, compared with the road, is that no man travels over it constantly to observe the defects therein.

I will say that there are two principal features in maintenance work, and these do not come at the same time. The first of these features is as described as happening over the period of the first year

after construction. The other feature does not make its appearance to any great extent until about two years after construction and that is the growth of vegetation in the top banks of the ditch, and on the berms, and unlike the first feature, this has no limit of time for the care necessary to the welfare of the ditch, for usually in these rich soils the growth of vegetation is very abundant when it has been drained, and the weeds and brush that spring up on the edges of the ditch if not cleared away will be blown by the wind and weighted down by rains into the ditch, and when it is running full of water these weeds and brush become serious obstructions to the free flow of the water, being drawn down into the ditch, catching floating matters, forming temporary rafts and causing the ditch to overflow its banks. This growth should be cleared from the berm and sides of the ditches regularly every year, and it should be done systematically; that is, over the entire length of the ditch for if the ditch becomes impaired at one place it will eventually have its bad effect over the entire system, and it should be the duty of some responsible person who has been employed to care for this special work. I have observed some instances where the ditch banks and berms have been kept in excellent condition by the owners of the lands adjacent to the ditch, by cultivating the space of the berm. This of course may not be profitable from the standpoint of farming, owing to the narrowness of the space between the waste bank and the edge of the canal; but to consider the good rendered to the welfare of the said canal, it may be considered as a profitable work. Where the berm is thus kept clean for agricultural purposes, the small amount of growth coming in the top banks of the canal can be easily gotten at and kept clean with very little trouble. But even in this case it should be a duty of some overseer or inspector to go over the entire system occassionally, for there will be some probable obstructions from some cause or other that may be in some remote section where it will unlikely have the attention at the proper time, and this inspector should be provided with the means for the removal of such obstructions and enable the ditch to render the service sought to be given by its construction.

One reason why I make special reference to the importance of constructing the ditch to its most adaptability to the soil, and giving the best possible grade to the bottom, is caused by my observations of the attention the average ditches are given after their construction. The maintenance work in most of the districts I have had occasion to see, is neglected to the extent that it is a hard problem to devise plans to repair and bring the ditch's condition back to its original standard of efficiency, unless it should be in a case where a canal has

been neglected until it has filled up to the extent that it will require the work of a dredge to re-excavate it, which will be equal in cost to the cutting of a new canal. This problem, at this time, awaits the development of a public realization of economy of ditch maintenance, and when the necessity is more fully realized methods will no doubt speedily be evolved for accomplishing the work.

DRAINAGE ASSESSMENTS IN NORTH CAROLINA

BY GEO. R. BOYD, Senior Drainage Engineer U. S. Department of Agriculture

Introduction

In any organization for the construction of drainage improvements there are a multitude of problems which must be solved. Of all these problems it is safe to say that the one which causes the greatest dissension among the landowners, the greatest number of lawsuits with their accompanying expenses and delays, and the largest number of failures to complete the organization of proposed drainage districts is the problem of apportioning the cost among the affected landowners. The North Carolina Drainage Law specifies that the lands shall be classified according to the special benefits which each tract will receive from the proposed improvement. Theoretically this requirement,—that each owner should pay according to the benefit which he receives,—is so eminently fair and just that none can be found to question it. Since this is true it must follow that the source of the dissatisfaction with the assessments as they are being made lies in the methods used in applying this principle. The weakness must be in the practice rather than in the theory.

The purpose of this paper is to set forth some of the established principles of assessments according to benefits; to show how, in my opinion, the North Carolina statute fails to observe or follow these principles; and to recommend for your consideration a method which seems likely to give better satisfaction than that now in use.

The Principles of Assessments According to Benefits

Since all assessments are to be proportioned according to benefits received, let us first get clearly before us the exact meaning of the word "benefit." In Bouvier's Law Dictionary, we find "benefit" defined as "profit, fruit or advantage," and it is thought that this is correct as to the sense in which the word is used in assessment work, provided that it is understood as meaning "gross profit" or "gross advantage" rather than the net profit or advantage. The reason that gross benefits are used in making assessments is that the assessments cannot

be determined until after the benefits are estimated, and as the assessments are to be proportional to the benefits, it is just as correct and much more simple to consider the gross benefit or profit as it would be to use the net profits derived from an assumed assessment.

There are two kinds of benefits resulting from the construction of local improvements; general benefits and special benefits. General benefits are those which, while arising from the improvement, are enjoyed by the public at large and are common to all the people in the vicinity. No assessments can be made on account of general benefits, but they must be present before an assessment district can be formed. The general benefits usually accruing to the public from drainage works are increased healthfulness, convenience and general prosperity.

Special benefits are those which are peculiar to some certain lands. These benefits are the ones on which the assessments rest, and in the case of drainage improvements, they have been said to include "whatever will come to the land to make it more valuable for tillage, or more desirable as a place of residence, or more valuable in the general market." Special benefits differ in degree rather than in kind from general benefits, and in certain cases may very well include the elements of increased healthfulness and convenience. This over-lapping of the two kinds of benefits sometimes leads to confusion, due to the very natural desire of the drainage authorities to include all of the land possible within the assessment district. The best rule for differentiating between the two classes of benefits is that a special benefit must be large enough and distinct enough to affect the value of the land in question.

There are a great many elements of special benefits and just what they are depends on the circumstances in each case. However, they all have certain characteristics and limitations.

In the first place, special benefits must be certain and sure. It is not enough to say that benefits may develop. Future benefits should be considered only when they will surely arise within a reasonable time. A special benefit need not be direct, but it may be indirect or collateral.

Only special benefits due primarily to the improvement can be entertained. As an abstract proposition, this limitation is so fair and just that it requires no proof as to its equity. In practice, however, it is a common thing to find that this requirement is not being carried out in making assessments. In the main, these failures are the results of neglect upon the part of the viewers to give the landowner proper credit for the natural or artificial advantages which pertain to and are a part of his property. When a man buys a piece of property he acquires with that property certain rights and privileges in connection

with the lawful use of it which are as surely his own as is the land itself. One of these is any advantage, or disadvantage, either natural or artificial or as a matter of law, which the property has in regard to the drainage of surface water. If the property be high and well drained, the owner cannot be forced to pay for any drainage work unless it improves his drainage, gives him some other benefit, or relieves him of a burden, for good drainage is one of the properties which pertain to his land and for which he paid when he bought the property. Likewise, if such an advantage has been secured artificially by the construction of ditches or drains, full credit must be given the owner for the benefit secured by such works.

To illustrate a type of cases in which the line is not sharply drawn between the benefits due to drainage and those due to other causes, let us suppose that a farmer rents a horse for work on his farm during the crop season. Now, the benefits, or profits, due to the horse would be the difference in the value of the crop raised with the horse and the value of the crop which might have been raised without him. But this is true only if the farmer did not work any harder, or longer, or did not use any machinery which he would not have used without the horse. Any expenditure for labor or use of machinery is entitled to a part of the increased return due to its use with the horse. It is frequently asserted that if a wet unproductive piece of ground be drained and then produces a return of twenty dollars per acre annually, the benefit due to drainage is twenty dollars per acre per year. This statement is an error whenever the amount of labor or money spent annually on the land is increased after drainage, since a part of the twenty dollars is profit due the farmer on account of his increased investment. If a landowner must do some work to secure the full benefit of improved drainage he is under a disadvantage as compared with others whose work is done by the drainage district. The amount of this disadvantage is not the actual cost of doing such work, since the owner is entitled to a profit on any money he expends for such a purpose. These are but a few of the many examples that are constantly arising which show the need for a clearer idea of what a drainage benefit is, and the necessity for drawing a sharp and clearly defined line between benefits arising from drainage improvements and those due to other causes.

The amount of benefit received by a tract of land from drainage improvement depends upon the physical features which surround that tract and upon the amount of drainage provided. Because both of these features are never the same for any two tracts the amount of benefit must also vary. It is for this reason that each tract must be considered separately by the viewers.

Again, the amount of benefit which any tract of land will receive from drainage is a certain definite sum of money. To be benefited the value of the land must be increased, and since money is the only measure of value we have, the benefit must be measured in dollars and cents. Every assessment which is attacked in court must stand or fall on the showing made by the facts with regard to the amount of benefit and the amount of the assessment, both evaluated in dollars and cents. More than this, the advantage and disadvantage of property with regard to drainage are susceptible of being measured in dollars—in fact they are so measured every time land is sold.

It is right and proper in considering benefits to consider the use that is being made of the property or the use for which it is suitable. The kind and amount of the resulting benefits will be different for lands used for different purposes. The benefit on which the assessment is to be based should be the one which will result when the land is used for that purpose for which it is most valuable.

To sum up the characteristics of special benefits, we may say that they are those benefits which are so distinctively peculiar to the tract in question that they will increase its value; they may be either direct, indirect, present or future; they cannot include any benefits due to any advantages which may belong to the land, or to any cause except the improvement; and because of the varying conditions which affect the amount of benefit, individual consideration is required of all the affected land.

North Carolina Practice

The North Carolina Drainage Law—Chap. 442, Public Laws 1909—provides that the assessments shall be made by two steps. The first step is the subdivision of the lands in the District into five classes with reference to the benefits which will accrue. The second step in the process is the levying of such sums of money against the lands in the several classes as will equal the cost of the proposed work.

This statute requires that the first step shall be made by the board of viewers, who shall divide the land into five classes with regard to the following factors—the degree of wetness of the land, its proximity to the ditch or natural outlet, and the fertility of the soil.

The factor "degree of wetness of the land," or, as it is sometimes called, "the need for drainage," is the most important factor, and is rightfully considered under this or any other method of making assessments. Unfortunately, there is usually no well defined margin

between the different degrees of wetness, and they do not lend themselves to a clear division into five or ten or any definite number of classes.

The second factor to be considered by the viewers is that of proximity to the ditch. Since it is physically impossible to give every tract the same amount of drainage, the resulting benefits will be unequal. Under this plan where a piece of land is at some distance from the main ditch or outlet, the classification of that land as fixed by the first factor must be reduced to compensate the owner for his disadvantage of having to connect his drains with the outlet provided by the District. This disadvantage is a certain sum of money, which may here be assumed to be the cost to the owner of constructing such a connecting ditch plus a reasonable return on such an investment. This cost depends on the distance he has to go, the amount of fall available, on the depth of the ditch, and on the amount of water which the connecting ditch must carry. Any or all of these factors have almost as great an effect upon the cost of the connecting ditch as does the one factor—distance from the improvement—which the statute says shall be the only one considered. The cost of such a connecting ditch can be determined in any case by the engineer in a very few minutes from the information required to be shown on the drainage map, and the amount of the disadvantage can then be determined. The owner is entitled to that amount,—no more and no less. But under this statute the only way in which an allowance can be made in such a case is by reducing the class of the land from "A" to "B" or "C" or "D", etc.—reductions which are largely indeterminate and of unknown value, and may or may not approximate the actual amount of the disadvantage of being at a distance from the improvement.

The third factor to be considered under the statute is the fertility of the soil. It has been said many times that "It is of more benefit to drain rich than poor land," but I believe that this is a mistaken idea. Returning to our illustration of the farmer and his rented horse, let us suppose that the farmer rents two horses, working one on a fertile field and the other on a field with poor soil. The return from the fertile field will be larger than that from the poor field, but the benefit or profit due to the horses will be the same if all other things are equal. The increased return from the more fertile field is due to the greater value of the field or in other words to the greater investment which the farmer has in the rich field. So it would seem that the fertility of the soil is one of the natural advantages of the land for which the owner pays when he buys the property, and he cannot by means of a drainage assessment based on his larger return, be

made to pay a penalty for his larger original investment. Therefore, except under assessment methods similar to the one used here and then only when the land is so poor as to be practically worthless when drained, this factor of soil fertility should not be considered at all.

It would seem that at least one other factor should be considered under this system, and that is what may be called the "effect of the improvement." As has been said, the amount of drainage furnished has a large effect upon the benefit which may be expected. Very few drainage systems are built large enough to take care of the greatest possible rainfalls. The building of such systems can usually be justified economically where there is no danger to human life when the capacity of the system is exceeded. However, great floods do not affect all the land in the district to the same degree for as a rule only the lower lands are so affected. In some cases this flood danger has been great enough to make some of the low lands almost as worthless after drainage as they were before. As a general proposition there are now sufficient rainfall records available in this section so that an engineer can tell quite accurately how often and to what extent any drainage system will be overflowed, so that there should be no difficulty in making the proper allowances for damages of this kind. The same thing is true in regard to the sufficiency of the outlets. Outlets naturally are not always perfect, and when they are imperfect the effect is not felt in the same degree by all the lands in the district, so that corrections should be made on this account where necessary.

The second step in making the assessments is made by the Clerk of the Court after the final hearing. He orders a levy made upon all the classified lands in the ratio of 5, 4, 3, 2 and 1. That is, all lands put in class "A" by the viewers pay 5 mills per acre where the class "B" lands pays 4 mills, class "C" 3 mills, and so on. The total amount of the levy equals the cost of the work.

Thus the statute says, in effect, that all lands in Class "E" receive one-fifth of the benefit of Class "A", one-fourth of Class "B" lands, one-third of Class "C" lands, and one-half of Class "D" benefits. This is an entirely arbitrary rule and is without foundation in fact. Necessarily, the viewers will put the wettest lands that are adjacent to the improvement in class "A", and the highest lands at the greatest distance from the ditch in Class "E". Now, there is no reason why the resulting benefits should be in the ratio of 5 to 1. It is conceivable that in a particular case such a ratio might exist, but it is unthinkable that such a ratio will hold good throughout the widely different conditions which obtain in all of the drainage districts in this State. The same is true of the ratios between the other classes.

I recall two districts in this State where I helped to make the assessments in which the Class "E" lands were quite similar and probably received approximately the same amount of benefit, but the Class "A" lands received very different benefits. In one district the Class "A" lands were under water the year around—worthless for agriculture,—while in the other district the Class "A" lands—the lowest and wettest in the district—were overflowed but once or twice per year and were quite valuable for hay and pasture. The benefit received by the wet lands in the first district was greatly in excess of that received by the same class of lands in the second while the benefits in Class "E" lands in both districts were actually about equal; yet, under the statute rule, the Class "E" lands were supposed to receive one-fifth of the benefits received by the Class "A" land.

The truth of the matter is that because of the wide variety of conditions which affect the drainage properties of land and consequently the amount of the benefit derived from drainage improvements, there can be no fixed relation between the benefits received by the various classes into which the lands may be divided. This is true whether you are considering the lands in only one district or in many districts, and whether they are divided into five or ten or more classes.

Probably the greatest objection which can be brought against this system of making assessments is that it is confusing and indefinite to both the viewers and the landowners. It is impossible for the viewers to know what the effect will be in dollars and cents when they make a change in the classification of a parcel of land until the classification and the computations are completed. That is, if a tract of land is one-half mile from the improvement, the viewers may wish to reduce its assessment a certain amount to allow for this disadvantage. The only way this can be done is to reduce the class of the land from "A" to "B" or "C", etc., but it is absolutely impossible for the viewers to tell how much difference there will be in the assessments of these various classes, until after the assessment roll is completed, which is usually not done until after the final hearing, when it is too late to change the classifications. Furthermore, the landowners, while they are entitled to the fullest knowledge of what their assessments will be, are without any knowledge of their amount until after it is too late for them to object if they so desire. All drainage improvements to be successful must rest on a firm business basis, and since this is true, there is nothing to fear in showing the landowner the probable amount of his assessment. Without this knowledge it is impossible for him to tell whether the project will be a paying one for him personally, and he is certainly entitled to the right to determine this question for him-

self. It is impossible for the landowner to intelligently make up his mind in regard to the reasonableness of his assessment when he is told that he has 50 acres in Class "A", 10 acres in Class "B", and so on. I firmly believe that the best policy in promoting drainage district improvements is to put all the cards on the table,—to show the landowner the benefits and the costs he may expect in dollars and cents, before the final hearing while he still has a chance to object to the formation of the district if he so desires. The present statute tends to cover up and confuse the issue, while I believe that the landowners should be given all the facts possible in order that they may fully understand what they are undertaking.

I would not have you believe that just and equitable assessments cannot be made under the present statute. I feel sure that by juggling, shifting and adjusting the boundaries between the various classes, in the exercise of good judgment, it is entirely possible to make a fair assessment. I believe that the great majority of the assessments that have been made have been fair and just because the viewers have been men of good judgment. What I wish to emphasize is the fact that because of its arbitrary requirements the statute violates some of the underlying principles of local assessments, and makes the levying of equitable assessments a matter of great difficulty.

The Recommended Method

In conclusion, I would like to recommend for your consideration a method which seems to give the best results of all those now in use in making drainage assessments.

In short, this method consists of evaluating in dollars and cents the special benefits accruing to each tract and then levying, as assessments, such a part of the total benefits as will raise the required amount of money. Following directly the theory of local assessments, this method proceeds to the heart of the whole matter by determining the monetary value of the resulting benefits. When this method is used the proceedings show the total benefits to be derived and the total cost, thus giving the landowners, the Court and the bond buyers *prima facie* evidence of the profitableness of the project. The proceedings also show the facts which must be shown in Court to sustain any assessment, that is, the relation between individual benefits and individual assessments; and that the individual assessments are proportional to the individual benefits throughout the district. It is a simple method and one that can be easily explained to and understood by great numbers of people. If administered with good judgment it results in assess-

ments which are fair and just since it proportions the costs according to the results rather than according to some arbitrary rule as is the tendency under the present statute.

Theoretically, this method is applicable under all conditions and to all kinds of property, since every kind and degree of special benefits must affect the value of the property. There are, however, some conditions under which it cannot be used,—the most common being the case where the amount of benefit is so small in comparison with the value of the property that it can have no appreciable effect upon the market value of such property. Assessments against certain classes of property, or rather against land used for certain purposes,—fall naturally into this class, as for instance, railroads, highways, and municipalities, when they are assessed as a whole. For assessing agricultural land, this method is as nearly perfect as any matter can be into which the judgment of man with its liability to error enters.

From a practical standpoint, the use of such a method has proven entirely feasible, and such use has resulted in assessments which are generally equitable. It has been used successfully for some years past by six of the states under a great variety of conditions, and several other states are now planning to adopt this method. The method generally used is to determine the value of each individual tract before and after drainage, the difference being the benefit due to the drainage improvement. Usually the value of the undrained land is a matter of common knowledge, while its improved value is always comparable to the value of high or drained land in the vicinity. Of course, the drainage properties of the land and the effect and the amount of the drainage furnished each individual tract must be taken into consideration, but as has been said, all of these things are susceptible of being evaluated in dollars and cents. It has been found that even small factors affecting the amount of benefit can be so evaluated. On the other hand, a study of the dividing line between benefits due to drainage and the advantages pertaining to the land itself, results in the discovery that many things which caused confusion and added complicating details to the old assessment methods are not drainage benefits but advantages belonging to the owner, thus simplifying the assessment method.

Finally, I would urge that this Association take some action looking toward the abandonment of that section of the Drainage Law defining the method of making assessments, since it prescribes the use of a system so narrow and arbitrary that it is almost impossible to make an equitable assessment under it, and to replace it with a provision whereby the assessments shall be proportioned according to the actual benefits,

in dollars and cents, as they may be determined by the Board of Viewers. The present method is essentially arbitrary, confusing to both viewers and landowners, while the recommended method is theoretically correct, simple and clear to all, and its value has been demonstrated in actual practice under a great variety of conditions.

BUSINESS SESSION

The President called for reports of the several committees, which were made as follows:

Resolutions Committee

The Committee on Resolutions respectfully report the following declarations and resolutions and recommend their adoption:

The North Carolina Drainage Association, organized in 1907, has a constructive record of benefits to the State creditable to the men and women who have been active in its maintenance. Since its organization a modern Drainage Law has been enacted by the Legislature at the session of 1909, and this law, with the several amendments thereto, were initiated by this Association. Under this law it is estimated that 600,000 acres of virgin land from which the merchantable timber had been removed has been reclaimed by drainage and subjected to cultivation. Prior to drainage these cut-over swamp lands produced no income and had only a speculative value, and could probably be purchased at a sum not exceeding $5 per acre. Since being drained, these lands are producing abundantly corn and other staple crops, have a large net earning capacity, and will sell in the market at prices ranging above $40 per acre. A momentary calculation will show the large accretion to the wealth of the State arising out of the increased market value of these lands and the value of the products produced therefrom.

The drainage movement, however, only covers partially the field for development. There are still many thousands of acres of cut-over wet and swamp lands awaiting reclamation. The fertility of these lands has been demonstrated not only by the opinion of experts, but by an actual test of their productivity. But the swamp lands of the Coastal Plain section not alone invite reclamation. In the Piedmont section and in the Mountains there are fertile valleys subject to overflow and uncertain in production which require scientific drainage which will enlarge their productive capacity and enhance their value and release them from the contingency of overflow and crop destruction.

We would also emphasize the fact that there are many farms occupied as homes, some of which have been under cultivation for many years,

but which are insufficiently drained and therefore uncertain in crop production and impaired in market value. The provisions of the Drainage Law should be utilized in the formation of drainage districts embracing these cultivated lands, thereby making them more attractive as homes and more valuable for agriculture.

As drainage districts are formed and the main canals are excavated leading to an adequate outlet, the construction of lateral drainways becomes essential. Under such conditions we urge upon the attention of the intelligent landowners the advisability of establishing tile drainage in substitution for the open lateral drainway. The original expenditure for tile drainage is greater, requiring more intelligent and careful supervision, but the ultimate results justify the expenditure and make the system more profitable.

We would not only emphasize the value of draining for increasing crop production and enhancing the value of our lands. Drainage is essential to permanent road construction. Good health and sanitation also wait upon drainage. Drainage and good roads make more accessible the school and the church. These incidental benefits should all be associated with the drainage of our wet lands.

Therefore Be it Resolved, That this Association continue its activities in the promotion and extension of the drainage of our wet lands in the State of North Carolina.

This Association wishes to extend its sympathetic coöperation with all other constructive organized movements for the public welfare. Among others, we may specify the North Carolina Good Roads Association which has adopted a plan for a system of National, State and County highways, to which it is devoting intelligent and progressive work and is making a distinct impression upon the people of the State and arousing civic pride in the construction of hard surfaced roads. We wish the North Carolina Good Roads Association success and will heartily cooperate with its officers and members.

The North Carolina Landowners Association, under the leadership of men and women who have caught the vision of the essentials for public betterment, is entitled to the sympathy and aid of all forward-looking citizens. The North Carolina Landowners Association is promoting good roads, better school facilities, drainage, health and sanitation, the eradication of the cattle tick and the reduction of hog cholera and the introduction of more and better livestock. Surely this array of constructive work will appeal to this Association and the people of the State.

Resolved, That the membership in attendance upon this meeting will undertake to spread among the people of their respective locali-

ties the purpose of this Association, will strive to enlarge its membership and to increase attendance at future meetings.

We are constrained to emphasize the importance to improve agriculture, of the introduction and production of more and better livestock. North Carolina possesses the climatic conditions and the capacity to produce the essential food stuffs for the sustenance of livestock. Improved varieties make for larger profits. Livestock and plant production are indissolubly united. The maintenance of soil fertility is made easier and cheaper by livestock upon the farm. We cannot safely introduce improved breeds of cattle unless we eradicate the cattle tick. The ravages of hog cholera must be curtailed if we would increase our hog production. A stock law is also essential in any intelligent movement for a more and better animal production.

Resolved, That this Association unreservedly indorses the existing Federal and State coöperative activities for the eradication of the cattle tick, which means the elimination of the cattle Texas fever and other diseases.

Resolved, That in our opinion the time has arrived for the enactment of a State-wide stock law. A large proportion of the counties in the State have already adopted such a stock law, and we should follow the example of our sister State of South Carolina in the enactment of such a progressive law applicable to the entire State.

This meeting, held in Washington, North Carolina, has been marked by a fine civic spirit and by addresses and the discussion of vital problems which have been beneficial and thought-provoking. The social features have been interesting and attractive.

Resolved, That the thanks of the Association are hereby tendered to the officers, committees and speakers who have contributed so much to the success of its deliberations at this meeting.

Resolved, That the thanks of the Association are tendered to the Chamber of Commerce and the citizens of Washington for their courteous consideration.

Resolved, That thanks are tendered to the local lodge of the Benevolent and Protective Order of Elks for the use of their hall and facilities for holding the meetings.

Resolved, That we specifically thank the ladies who have participated so helpfully at this meeting, among whom we may mention Miss H. M. Berry, the efficient Acting Secretary; Miss Minnie Queen, who has reported our proceedings; and Miss Lillian J. Halle, the Acting Secretary of the Chamber of Commerce of this city.

Respectfully submitted,

P. H. JOHNSON,
Chairman.

We sincerely regret the absence from this meeting of Dr. Joseph Hyde Pratt, the capable and active Secretary of this Association. Dr. Pratt has rendered distinguished service to the State and has been affiliated with several important activities. He is director of the North Carolina Geological and Economic Survey; Secretary of the North Carolina Good Roads Association; an active member of the American Association of State Highway Officials; and a member of the Executive Committee of the National Drainage Congress. He was among the first to tender his services when this country entered the recent world war and was promoted to the grade of Colonel of the 105th Engineer Regiment, Thirtieth Division. This was one of the Divisions which saw active service at the front, in which Colonel Pratt and his regiment actively participated. Shortly after his return from overseas and his discharge from the service, he was overtaken with a serious illness, directly attributable to the hazards of the service, and is still being treated at the hospital.

Resolved, That the Association tender to Colonel Pratt their solicitude and good wishes for his early restoration to health, with the hope that he may assume his life of service in the upbuilding of the State.

Resolved Further, That the Secretary be directed to forward to Colonel Pratt a copy of this preamble and resolution.

Respectfully submitted,

P. H. JOHNSON,
Chairman.

Membership Committee

The membership committee reported 126 registered, representing 25 counties; and 15 from other States. It was recommended that the annual dues be increased to $5, which was adopted by the Association.

Committee on Nominations and Next Meeting Place

President: Hon. John H. Small

Secretary and Treasurer: Joseph Hyde Pratt

1st Vice-Presidents: John E. Shepardson, Belhaven, N. C.
(In charge of District Drainage)
H. M. Lynde, West Raleigh, N. C.
(In charge of Farm Drainage)

It was moved and carried that the Convention itself decide on the time and place for the next meeting.

Invitations were extended by the following places: Elizabeth City, Tarboro, Goldsboro, Greenville, Washington and Greensboro. After considerable discussion, it was decided to hold the next annual convention at Elizabeth City.

Miscellaneous Business

The following letter from Judge N. A. Morris of the *National Drainage Journal* was read to the Convention by the Secretary:

HON. JOSEPH HYDE PRATT,

Chapel Hill, N. C.

My dear Sir:

I have been away for two weeks, and on my return found your letter and telegrams. I regret very much that court engagements will prevent my being with you to deliver an address at Washington at the meeting of your North Carolina Drainage Association. Forsyth Superior Court will be in session at that time, and it will be impossible for me to leave.

I will have the *National Drainage Journal* mail you a number of copies of the March issue for distribution at your North Carolina meeting. If you can do so, I wish you would get a resolution through the North Carolina Drainage Association adopting the *National Drainage Journal* as the official organ of your Association. The Georgia Drainage Association and the National Drainage Congress adopted this publication, which is the only one in existence which is devoted exclusively to the promotion of drainage, as their official organ.

We would like very much for you to send to the *National Drainage Journal* the speeches or copies thereof, that are delivered at this meeting, and we will be glad to publish them in the *National Drainage Journal* without cost. Hope you will see that they are sent forward as early as possible.

Yours very truly,

(Signed) N. A. MORRIS.

A motion was made and passed adopting the *National Drainage Journal* as the official organ of the Association.

DELEGATES REGISTERED AT DRAINAGE CONVENTION

Washington, North Carolina, March 31—April 1, 1920.

Anson County—

Broome, W. P. .... Peachland, N. C.

Beaufort County—

Archbell, M. T. .... Washington, N. C.
Bocker, H. .... Washington, N. C.
Bonner, B. T. .... Aurora, N. C.
Bonner, J. H. .... Washington, N. C.
Bowen, G. W. .... Washington, N. C.
Bullard, Dr. W. J. .... Belhaven, N. C.
Chauncey, R. T. .... Washington, N. C.
Cotten, J. M. .... Washington, N. C.
Daniel, E. A., Jr. .... Washington, N. C.
Dodd, J. G. .... Belhaven, N. C.
Edgerton, F. M. .... Belhaven, N. C.
Halle, Miss L. J. .... Washington, N. C.
Hardison, Simon .... Washington, N. C.
Hardy, Ben .... Washington, N. C.
Hodges, T. R. .... Washington, N. C.
Jackson, C. M. .... Washington, N. C.
Johnson, P. H. .... Pantego, N. C.
King, C. S. .... Belhaven, N. C.
Knobloch, S. A. .... Belhaven, N. C.
Kugler, Frank C. .... Washington, N. C.
Latham, F. P. .... Belhaven, N. C.
Latham, John F. .... Bath, N. C.
Mengel, C. W. .... Belhaven, N. C.
Morrison, W. D. .... Belhaven, N. C.
Nickerson, C. R. .... Belhaven, N. C.
Paul, J. D. .... Washington, N. C.
Ricks, Geo. E. .... Pantego, N. C.
Rodman, W. D. .... Washington, N. C.
Ross, C. V. .... Bonnerton, N. C.
Schondor, M. H. .... Terra Ceia, N. C.
Shelburn, V. B. .... Washington, N. C.
Shepardson, Jed .... Belhaven, N. C.
Shepardson, John E. .... Belhaven, N. C.
Small, Hon. John H. .... Washington, D. C.
Smith, Fred .... Washington, N. C.
Smith, J. B. .... Washington, N. C.
Smith, M. O. .... Washington, N. C.
Strain, David L. .... Belhaven, N. C.
Sumner, S. F. .... Washington, N. C.
Williams, W. H. .... Washington, N. C.
Woolard, W. A. .... Washington, N. C.
Woolard, W. H. .... Washington, N. C.

Burke County—

Pitts, J. D.......................................Glen Alpine, N. C.

Chowan County—

Matthews, Pat.......................................Edenton, N. C.
Perry, E. C.......................................Tyner, N. C.
Rowell, N. K.......................................Edenton, N. C.

Edgecombe County—

Cawley, H.......................................Cash Corner, N. C.
Cherry, J. L.......................................Hobgood, N. C.
Gatlin, R. H.......................................Tarboro, N. C.
Savage, A. R.......................................Speed, N. C.

Forsyth County—

Hire, A. E.......................R. F. D. No. 1, Winston-Salem, N. C.

Hyde County—

Hanford, George S.......................................New Holland, N. C.
Ponzer, K. S.......................................New Holland, N. C.
Radcliff, Geo. T.......................................Leechville, N. C.
Spencer, C. B.......................................Swan Quarter, N. C.

Jones County—

Haywood, W. H.......................................Trenton, N. C.
Whitaker, T. C.......................................Trenton, N. C.

Martin County—

Holliday, Jos. L.......................................Williamston, N. C.

Mecklenburg County—

Alexander, W. D.......................................Charlotte, N. C.

Moore County—

McNeill, W. H.......................................Lake View, N. C.

New Hanover County—

Allen, W. K.......................................Wilmington, N. C.
Bledsoe, S. B.......................................Wilmington, N. C.
Cashwell, C. C.......................................Wilmington, N. C.
Low, Dr. Chas. E.......................................Wilmington, N.C.
McGirt, W. A.......................................Wilmington, N. C.

Onslow County—

Henderson, F. C.......................................Maysville, N. C.
Herritage, J. I.......................................Jacksonville, N. C.
Latham, D. L.......................................Jacksonville, N. C.
Morton, H. T.......................................Kellum, N. C.
Morton, Roney.......................................Kellum, N. C.

Orange County—

Saville, Thorndike.......................................Chapel Hill, N. C.

Pamlico County—

Farnell, Geo. T. .... Bayboro, N. C.
Fought, Willie .... Bayboro, N. C.
Harmon, P. C. .... Bayboro, N. C.

Pasquotank County—

Bradley, J. W. .... Elizabeth City, N. C.
Cohoon, F. F. .... Elizabeth City, N. C.

Perquimans County—

Fleetwood, J. J. .... Hertford, N. C.
Winslow, A. R. .... Winfall, N. C.

Pitt County—

Boyd, C. E. .... Grimesland, N. C.
Cotten, R. R. .... Bruce, N. C.
Cox, Dr. B. T. .... Winterville, N. C.
Hardee, I. E. .... Grimesland, N. C.
Keel, W. G. .... Bethel, N. C.
Proctor, H. H. .... Grimesland, N. C.
Proctor, T. F. .... Grimesland, N. C.
Smith, Lonnie .... Grimesland, N. C.
Taylor, Arthur .... Grimesland, N. C.
Whitehurst, R. D. .... Bethel, N. C.
Williams, J. B. .... Grimesland, N. C.
Williams, Heber .... Grimesland, N. C.
Williams, J. A. .... Grimesland, N. C.

Richmond County—

Hayden, C. J. .... Hamlet, N. C.

Surry County—

Barber, I. W. .... Mt. Airy, N. C.

Tyrrell County—

Cobb, Wm. B. .... Columbia, N. C.
Davis, W. A. .... Columbia, N. C.

Wake County—

Bartel, Frank O. .... Raleigh, N. C.
Fuchs, A. W. .... Raleigh, N. C.
Green, R. W. .... Raleigh, N. C.
Joyner, Andrew .... Raleigh, N. C.
Lynde, H. M. .... Raleigh, N. C.
Sherwin, M. E. .... West Raleigh, N. C.

Wayne County—

Peirce, Major W. W. .... Goldsboro, N. C.

Washington County—

Brewder, P. W. .... Plymouth, N. C.
Cline, A. S. .... Wenona, N. C.
Darden, P. H. .... Plymouth, N. C.
Glover, A. L. .... Wenona, N. C.
Harrison, N. H., Jr. .... Pinetown, N. C.
Harrison, N. H., Sr. .... Pinetown, N. C.
Heynor, R. C. .... Wenona, N. C.

Wilson County—

Gaither, E. W. .... Wilson, N. C.

Other States—

Benham, Wm. G., President, The R. L. Dollings Co. .... Columbus, Ohio.
Boyd, Geo. R., Engineer, U. S. Dept. of Agriculture .... Washington, D. C.
Briggeman, Mrs. L. M., Asst. Secretary, Southern Settlement and Development Organization .... Baltimore, Md.
Brown, S. D., U. S. R. R. Co. .... Norfolk, Va.
Graves, D. N., Lake Mattamuskeet Project .... Winchester, Mass.
Jones, Jessie M., General Development Agent, S. A. L. R. R., ... Norfolk, Va.
Lever, Hon. A. F., Federal Farm Loan Board .... Washington, D. C.
Moseley, L., Thompson & Moseley, Attorneys .... Atlanta, Ga.
Rowland, W. W. .... Sumter, S. C.
Smith, R. K., Vice-President, John L. Roper Lumber Co. .... Norfolk, Va.
Ucker, Clement S., Secretary, Southern Settlement and Development Organization .... Baltimore, Md.
Widgeon, J. M. .... Norfolk, Va.
Wilbanks, Jno. R., Lake Mattamuskeet Project .... Columbus, Ohio
Speight, S. C. .... Norfolk, Va.
Walker, J. A. .... Petersburg, Va.

PUBLICATIONS

OF THE

GEOLOGICAL AND ECONOMIC SURVEY

BULLETINS

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*

2. Building and Ornamental Stones in North Carolina by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906. 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 50 cents extra.*

3. Gold deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of Print.*

4. Road Material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of Print.*

5. The Forests, Forest Lands, and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Out of Print.*

6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of Print.*

7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Out of Print.*

8. Water powers in North Carolina, by George F. Swain, Joseph A. Holmes, and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Out of Print.*

9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Out of Print.*

10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of Print.*

11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Out of Print.*

12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 8°, 60 pp., 15 pl. *Out of Print.*

13. Clay Deposits and Clay Industries in North Carolina, by Heinrich Ries, 1897. 8°, 157 pp., 12 pl. *Out of Print.*

14. The Cultivation of the Diamond-back Terrapin, by R. E. Coker, 1906. 8°, 67 pp., 23 pl., 2 figs. *Out of Print.*

15. Experiments in Oyster Culture in Pamlico Sound, North Carolina, by Robert E. Coker, 1907. 8°, 74 pp., 17 pl., 11 figs. *Postage 10 cents.*

16. Shade Trees for North Carolina, by W. W. Ashe, 1908. 8°, 74 pp., 10 pl., 16 figs. *Out of Print.*

17. Terracing of Farm Lands, by W. W. Ashe, 1908. 8°, 38 pp., 6 pl., 2 figs. *Postage 4 cents.*

18. Bibliography of North Carolina Geology, Mineralogy, and Geography, with a list of Maps, by Francis Baker Laney and Katherine Hill Wood, 1909. 8°, 428 pp. *Postage 25 cents. Cloth-bound copy, $1.00.*

19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglas B. Sterrett, 1905. 8°, 64 pp., 8 figs. *Postage 4 cents.*

20. Water powers of North Carolina: An Appendix to Bulletin 8, 1910. 8°, 383 pp. *Postage 25 cents.*

21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8o, 137 pp., 23 pl., 5 figs. *Postage 15 cents. Cloth copies 75 cents.*

22. A Report on the Cid Mining District, Davidson County, N. C., by J. E. Pogue, Jr., 1911. 8o, 144 pp., 22 pl., 5 figs. *Postage 15 cents. Cloth copies 75 cents.*

23. Forest Conditions in Western North Carolina, by J. S. Holmes, 1911. 8o, 116 pp., 8 pl. *Postage 15 cents.*

24. Loblolly or North Carolina Pine, by W. W. Ashe, Forest Inspector, U. S. Forest Service (and former Forester of the North Carolina Geological and Economic Survey). Prepared in coöperation with the Forest Service, U. S. Deparment of Agriculture, 1914. 8o, 176 pp., 27 pl., 5 figs. *Postage 15 cents. Cloth copies 75 cents.*

25. Zircon, Monazite, and Other Minerals used in the Production of Chemical Compounds Employed in the Manufacture of Lighting Apparatus, by Joseph Hyde Pratt, Ph. D., 1916. 8o, 120 pp., 3 pl. *Postage 15 cents. Cloth copies 75 cents.*

26. A Report on the Virgilina Copper District of North Carolina and Virginia, by F. B. Laney, Ph.D., 1917. 8o, 176 pp., 20 pl., 16 figs.

27. The Altitudes of North Carolina, 1917. 8o, 124 pp. *Postage 20 cents.*

ECONOMIC PAPERS

1. The Maple Sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8o, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of Print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8o, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina, during 1900, by Joseph Hyde Pratt, 1901. 8o, 36 pp., and map. *Out of Print.*

5. Road Laws of North Carolina, by J. A. Holmes. *Out of Print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8o, 102 pp., *Out of Print.*

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8o, 27 pp. *Out of Print.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8o, 74 pp. *Out of Print.*

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8o, 95 pp. *Postage 4 cents.*

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8o, 39 pp. *Out of print.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8o, 95 pp. *Out of Print.*

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8o, 74 pp. 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8o, 78 pp. *Out of Print.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8o, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 80o, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, State Geologist, 1908. 8o, 45 pp. *Out of Print.*

17. Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908. 8o, 94 pp. *Out of Print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8o, 50 pp. *Out of Print.*

19. Forest Fires in North Carolina During 1909, by J. S. Holmes, Forester, 1910. 8o, 52 pp., 9 pl. *Out of Print.*

20. Wood-using Industries of North Carolina by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8o, 74 pp., 6 pl. *Out of Print.*

21. Proceedings of the Third Annual Drainage Convention, held under Auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified). Compiled by Joseph Hyde Pratt, 1911. 8o, 67 pp., 3 pl. *Out of Print.*

22. Forest Fires in North Carolina During 1910, by J. S. Holmes, Forester, 1911. 8o, 48 pp. *Out of Print.*

23. Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8o, 134 pp., 1 pl., 27 figs. *Postage 10 cents. Cloth copies 50 cents extra.*

24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8o, 44 pp. *Out of Print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8o, 71 pp. *Postage 5 cents.*

26. Proceedings of Fourth Annual Drainage Convention held at Elizabeth City, North Carolina, November 15 and 16, 1911, compiled by Joseph Hyde Pratt, State Geologist, 1912. 8o, 45 pp. *Out of Print.*

27. Highway work in North Carolina, containing a Statistical Report of Road Work during 1911, by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8o, 145, pp. 11 figs. *Out of Print.*

28. Culverts and Small Bridges for Country Roads in North Carolina, by C. R. Thomas and T. F. Hickerson, 1912. 8o, 56 pp., 14 figs., 20 pl. *Postage 10 cents.*

29. Report of the Fisheries Convention held at New Bern, N. C., December 13, 1911, compiled by Joseph Hyde Pratt, State Geologist, together with a Compendium of the Stenographic Notes of the Meetings Held on the two trips taken by the Legislative Fish Committee Appointed by the General Assembly of 1909, and the Legislation Recommended by this Committee, 1912. 8o, 302 pp. *Postage 15 cents.*

30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8o, 109 pp. *Postage 10 cents.*

31. Proceedings of Fifth Annual Drainage Convention held at Raleigh, N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist. 8o, 56 pp., 6 pl. *Postage 5 cents.*

32. Public Roads are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8o, 62 pp. *Postage 5 cents.*

33. Forest Fires in North Carolina during 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester, 1913. 8o, 63 pp. *Postage 5 cents.*

34. Mining Industry in North Carolina during 1911-12, by Joseph Hyde Pratt, State Geologist, 1914. 8o, 314 pp., 23 pl., 12 figs. *Postage 15 cents.*

35. Good Road Days, November 5th and 6th, 1913, compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8o, 102 pp., 11 pl. *Postage 10 cents.*

36. Proceedings of the North Carolina Good Roads Association, held at Morehead City, N. C., July 31st and August 1, 1913. In coöperation with the North Carolina Geological and Economic Survey.—Statistical Report of Highway Work in North Carolina during 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8o, 127 pp., 7 figs. *Postage 10 cents.*

37. Forest Fires in North Carolina during 1913 and a Summary of State Forest Fire Prevention in the United States, by J. S. Holmes, Forester, 1914. 8o, 82 pp. *Postage 8 cents.*

38. Forms covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments. And Forms for Minutes of Boards of Drainage Commissioners covering the Organization of the Board up to and Including the Issuing of the Drainage Bonds. Compiled by Geo. R. Boyd, Drainage Engineer. 133 pp.

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the Departments of Civil and Highway Engineering of the University of North Carolina and the North Carolina Geological and Economic Survey. 8o, 117 pp., 15 figs., 4 pl. *Postage 10 cents.*

40. Forest Fires in North Carolina during 1914 and Forestry Laws of North Carolina, by J. S. Holmes, State Forester, 1915. 8o, 55 pp. *Postage 5 cents.*

41. Proceedings of Seventh Annual Drainage Convention of the North Carolina Drainage Association held at Wilson, North Carolina, November 18 and 19, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1915. 8o, 76 pp., 3 figs. *Postage 5 cents.*

42. Organization of Coöperative Forest Fire Protective Areas in North Carolina, being the Proceedings of the Special Conference on Forest Fire Protection, held as part of the Conference on Forestry and Nature Study, Montreat, N. C., July 8, 1915. Prepared by J. S. Holmes, State Forester, 1915. 8o, 39 pp. *Postage 4 cents.*

43. Proceedings of the Second Road Institute, held at the University of North Carolina, February 23-27, 1915. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1916. 8o, 128 pp. *Postage 15 cents.*

44. Highway Work in North Carolina During the Calendar Year Ending December 31, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1916. 8°, 55 pp. *Postage 10 cents.*

45. Proceedings of the Eighth Annual Drainage Convention. Held under the Auspices of the North Carolina Drainage Association and the North Carolina Geological and Economic Survey, Belhaven, N. C., November 29, 30, and December 1, 1915. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 90 pp. *Postage 15 cents.*

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NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY
JOSEPH HYDE PRATT, DIRECTOR

ECONOMIC PAPER No. [illegible]

FOREST FIRES IN NORTH CAROLINA DURING 1918, 1919, and 1920

AND

FOREST PROTECTION IN NORTH CAROLINA

BY
J. S. HOLMES, STATE FORESTER

RALEIGH
EDWARDS & BROUGHTON PRINTING COMPANY
STATE PRINTERS
1921

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

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ECONOMIC PAPER No. 51

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STATE GEOLOGICAL BOARD

LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., May 20, 1921.

To his Excellency, HONORABLE CAMERON MORRISON,
Governor of North Carolina.

SIR:—For the past twelve years the Survey has made a practice of collecting and publishing annually information concerning the extent and amount of damage caused by forest fires in order to impress upon the people of the State the need for greater care in handling fire in and near the woods. It is felt that this policy has been amply justified.

I am, therefore, submitting herewith for publication as Economic Paper No. 51 of the Reports of the North Carolina Geological and Economic Survey, a report on the "Forest Fires in North Carolina During 1918, 1919 and 1920 and Forest Protection in North Carolina." An Appendix, containing the names and addresses of all the Voluntary Township Forest Fire Correspondents who reported for 1920, has been added for the information and convenience of the public and as a recognition of the public-spirited service these citizens have continued to render to the State.

Yours respectfully,

JOSEPH HYDE PRATT, *Director,*
North Carolina Geological and Economic Survey.

PREFACE

The year 1920 completed the second phase of forest protection in North Carolina and the year 1921 begins a third.

The winter of 1908-09 saw the first strong effort to secure legislation for the protection of the forests of the State from fire. The General Assembly was not then interested because the people of the various counties cared little or nothing whether or not their woods were burned over. From then on to 1915, when the forest fire law was enacted, continuous publicity and education through publications, the press, meetings, lectures, correspondence, etc., was carried on by the State Geological and Economic Survey. This then might be termed the period of publicity.

Although the forest fire law of 1915 carried no appropriation, the fact that its enforcement was entrusted to the Geological and Economic Survey enabled this department to carry out some of the provisions for which the necessary amount of money was available. The coöperation of the Forest Service of the Federal Government in fire prevention was secured and a few men in selected districts were appointd Federal Patrolmen and State Forest Wardens. Only fourteen districts, comprising from one to several townships, had been started up to the end of 1920, and the wardens or patrolmen in charge of these districts were on duty only a comparatively small part of the year, just during the dry and dangerous spring and fall fire seasons. The efforts of these men have been directed not only towards the extinction of forest fires but largely towards arousing in the district an intelligent public opinion, which will work towards the *prevention* as well as the suppression of forest fires. This second period may be considered the experimental stage.

The extension period has begun with the appointment by the Survey of Mr. W. D. Clark as Chief Forest Fire Warden in the fall of 1920, and the increase of the annual appropriation of the Survey by the General Assembly of 1921, a part of which will be devoted to extending the forest fire prevention work. The policy of the Survey will be to continue work in the districts already established, provided the residents continue their interest and coöperation. Extension of the work to other districts will be guided and influenced by the amount and kind of coöperation which can be secured from the local landowners or the county authorities. The measure authorizing and empowering county commissioners to coöperate with the Survey in fire protection, recently enacted, will undoubtedly smooth the way for arranging coöperation of this kind. The passage of the state-wide stock law will have a very beneficial effect in reducing the causes and the number of forest fires.

Coöperation with the U. S. Forest Service, as authorized by the Weeks Law, will be continued and, due to the increased amount that the State Survey can allot for the protection of the forests of the State from fire, the State will receive much greater coöperation from the Federal Forest Service and will thus be enabled to protect greater areas.

Protection of forests from fire is a prerequisite for all other measures relating to the conservation and perpetuation of our forests. This is by far the most necessary and important measure for the State to intensively carry out, because the success of all others is dependent upon it. The principal object of such a measure is to prevent fires—not to wait until they are started and then extinguish them.

JOSEPH HYDE PRATT, *Director*.

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FOREST FIRES IN NORTH CAROLINA
DURING 1918, 1919 AND 1920

By J. S. Holmes, *State Forester*

INTRODUCTION

The prevention of forest fires has for the past few years been growing in importance until now it is one of the Nation's chief problems. It is estimated by the United States Forest Service that during the years 1916-1918 (the last years for which figures are available) an average annual damage of approximately twenty million dollars to timber and improvements was caused by an average of between thirty and thirty-five thousand forest fires. Less than ten per cent of these fires were caused by lightning, which is the only agency for starting fires beyond the control of man. Practically ninety per cent of our forest fires are due to human carelessness and therefore could be prevented if every one would take as much care as the most careful.

This state of things was brought to the attention of President Harding and within thirty days of his inauguration he issued a proclamation designating and setting apart the week of May 22-28, 1921, as *Forest Protection Week* and requesting "all citizens of their states to plan for that week such educational and instructive exercises as shall bring before the people the serious and unhappy effects of the present unnecessary waste by forest fires, and the need of their individual and collective efforts in conserving the natural resources of America."

In this proclamation President Harding clearly brings out what has been recognized by foresters for a long time, that one of the chief weapons for the prevention of forest fires is the education of the people to be more careful. It was with this object in view that the North Carolina Geological and Economic Survey started publishing in 1910 annual forest fire reports, based on information furnished by the leading and best informed citizens in their various communities throughout North Carolina, who without charge contributed this service for the good of their State. These reports have shown an alarming condition. An estimated loss of more than one million dollars a year for the past twelve years has occurred, almost entirely through the carelessness or indifference of our own people. At the same time a reduction in the yielding capacity of our forests through fire and destructive lumbering—and to a very small extent by necessary clearing—is greatly reducing the annual production of timber in this State, as it is throughout the country.

Only by preventing this unnecessary and disgraceful annual loss from fire can we hope to provide for the future needs of the State and Nation, which promise to be as great, if not greater, than they have been in the past.

FIRE SEASONS

The distribution of fires throughout the year, which showed an abnormal proportion of spring fires in the last published report, returns more nearly to normal in the accompanying table which shows the average distribution for the three years under consideration. An excessively dry and dangerous season resulting in a large number of fires may occur at almost any time of the year, and such an occurrence as the April fires of 1916 will give a disproportionate percentage of fires for that season. The past three years have been fairly average seasons so that this table is undoubtedly nearer to the normal than the one previously published.

TABLE 1.—AVERAGE RELATIVE MONTHLY AND SEASONAL FIRE RISKS FOR THREE YEARS, 1918, 1919, AND 1920, IN PERCENTAGES

	Mountain		Piedmont		Coastal Plain		State		
	Months	Seasons	Months	Seasons	Months	Seasons	Months	Seasons	
March	20		26		25		23		
April	24	54	25	60	22	56	23	56	Spring
May	10		9		9		10		
June	2		3		4		3		
July	1	4	3	9	3	9	2	7	Summer
August	1		3		2		2		
September	2		5		5		4		
October	8	26	6	19	7	19	7	22	Fall
November	16		8		7		11		
December	12		6		6		8		
January	2	16	2	12	4	16	3	15	Winter
February	2		4		6		4		

FOREST FIRES DURING 1918

The year 1918 was remarkable for the shortness and lightness of the fire seasons. Although the precipitation was light through March, what there was was well distributed; whereas, in April, a very heavy rainfall occurred, which also was well distributed over the month. In May the rains were sufficient to keep the woods moist almost all the time. There were few periods of high winds and comparatively few serious fires occurred. Four Federal Patrolmen were appointed in March and taken off the latter part of May. One, however, was not appointed until April, and the sixth only worked through the month of May. Four of these coöperated with Forest Fire Protective Associations, and the other two were patrolling whole counties.

The fall fire season commenced early in November, but by the middle of the month most of the serious danger was over. Throughout the State there were hardly any fires serious enough to call forth comment in the newspapers. Only one Federal Patrolman was appointed before November 1. They were taken off the second week in December.

TABLE 2.—FOREST FIRES IN NORTH CAROLINA DURING 1918

SUMMARY OF REPORTS FROM CORRESPONDENTS BY COUNTIES

Mountain Region

COUNTY	Total Number of Townships in County	Number of Townships Reporting	Number of Replies Received	Number of Fires	Total Number Acres Burned Over	Merchantable Timber Destroyed, M.	Value of Timber Destroyed	Value of Young Growth Destroyed	Value of Products Destroyed	Value of Improvements Destroyed	Cost of Fire Fighting	Total Damage Reported
Alleghany	7	5	9	2	300	....	$........	$........	$........	$ 100	$.....	$ 100
Ashe	15	7	12	1	20	....	....	50	....	30	.....	80
Avery	8	3	3	2	20	....	....	20	....	....	20	20
Buncombe	18	8	16	31	2,630	110	550	3,480	800	20	400	4,850
Burke	13	6	11	12	2,400	130	650	1,200	20	100	100	1,970
Caldwell	12	10	19	14	850	120	600	6,450	10,050	....	40	17,100
Cherokee	6	5	7	21	1,480	10	50	320	230	550	70	1,150
Clay	5	4	11	18	4,520	110	550	4,800	....	250	70	5,600
Graham	3	2	2	5	3,300	....	....	10,200	5,500	....	40	15,700
Haywood	13	7	17	11	360	30	150	1,100	700	....	300	1,950
Henderson	8	8	19	14	910	60	300	1,950	1,900	700	210	4,850
Jackson	15	9	13	24	4,880	220	1,100	1,500	7,000	200	100	9,800
Macon	11	9	17	13	4,750	30	150	1,300	500	300	50	2,250
Madison	16	12	22	8	1,320	60	300	1,300	400	100	60	2,100
McDowell	11	8	11	22	1,400	10	50	650	350	....	10	1,050
Mitchell	10	8	9	2	10	....	....	50	....	....	.....	50
Polk	6	5	8	2	....	....	....	20	....	....	10	20
Rutherford	14	8	13	24	790	100	500	1,400	1,000	200	150	3,100
Surry	14	11	29	27	160	....	....	610	150	....	20	760
Swain	4	1	1	3	14,000	100	500	20,000	....	....	200	20,500
Transylvania	8	5	9	23	3,550	50	250	8,500	80,500	150	20	89,400
Watauga	13	10	20	7	70	10	50	600	650	100	60	1,400
Wilkes	21	21	47	40	4,900	2,800	14,000	12,400	30,000	500	540	56,900
Yancey	11	9	26	90	3,380	50	250	7,100	10,250	1,700	230	19,300
Totals	262	181	351	416	56,000	4,000	20,000	85,000	150,000	5,000	2,700	260,000

TABLE 3.—FOREST FIRES IN NORTH CAROLINA DURING 1918

SUMMARY OF REPORTS FROM CORRESPONDENTS BY COUNTIES

Piedmont Region

County	Total Number of Townships in County	Number of Townships Reporting	Number of Replies Received	Number of Fires	Total Number of Acres Burned Over	Merchantable Timber Destroyed, M.	Value of Timber Destroyed	Value Young Growth Destroyed	Value of Products Destroyed	Value of Improvements Destroyed	Cost of Fire Fighting	Total Damage Reported
Alamance	14	7	15	3	110		$	$ 600	$	$ 100	$	$ 700
Alexander	8	5	6	3	1,120	10	50	6,500	800	3,500	210	10,850
Anson	8										10	
Cabarrus	12	7	12	6	10			50	50	30		130
Caswell	9	4	7	1								
Catawba	8	5	8									
Chatham	13	6	6	19	220	20	100	700	1,400	200	90	2,400
Cleveland	11	9	14	11	30			100	100	10		210
Davidson	17	10	18	21	80			300	50	250	80	600
Davie	7	7	11	4	100			250	100			350
Durham	7	4	4	5	110			100				100
Forsyth	14	9	12	12	20			150	500	500		1,150
Franklin	10	4	5	4	240			1,900				1,900
Gaston	6	4	6	6	200			400				400
Granville	9	7	9	20	310	10	50	800	5,000	550		6,400
Guilford	18	9	10	1	40			200				200
Iredell	16	6	11	15	40	10	50	550	20	10	50	630
Lee	7	1	2	1	50			400				400
Lincoln	5	4	5	3	54	180	900	1,000	2,500			4,400
Mecklenburg	15	10	14	2	1							
Montgomery	9	5	7	28	13,160	100	500	26,000	200		110	26,700
Moore	10	8	14	23	8,000	10	50	5,600		5,252	50	10,900
Orange	7	4	5									
Person	9	3	6									
Randolph	20	12	24	35	320	30	150	2,000	550		10	2,700
Rockingham	11	7	12									
Rowan	14	9	18	17	190	200	1,000	2,100	2,200	1,100	1,000	6,400
Stanly	10	6	9	7	130			300	160		10	460
Stokes	9	4	5	1	5			100	800	500		1,400
Union	9	8	10	2	20			200	20			220
Vance	9	7	8	11	300	10	50	800		850		1,650
Wake	19	11	18	26	1,000	1,400	7,000	3,000	500	10,000	10	20,500
Warren	12	7	8	3	80			400				400
Yadkin	9	9	14	18	60	20	100	500	50	150	70	800
Totals	371	218	333	308	26,000	2,000	10,000	55,000	15,000	23,000	1,700	103,000

TABLE 4.—FOREST FIRES IN NORTH CAROLINA DURING 1918

SUMMARY OF REPORTS FROM CORRESPONDENTS BY COUNTIES

Coastal Plain Region

COUNTY	Total Number of Townships in County	Number of Townships Reporting	Number of Replies Received	Number of Fires	Total Number Acres Burned Over	Merchantable Timber Destroyed, M.	Value of Timber Destroyed	Value of Young Growth Destroyed	Value of Products Destroyed	Value of Improvements Destroyed	Cost of Fire Fighting	Total Damage Reported
Beaufort	6	2	2	6	500	----	$----	$----	$2,000	$ 500	$----	$ 2,500
Bertie	9	7	8	----	----	----	----	----	----	----	----	----
Bladen	15	8	9	28	19,450	960	4,800	17,500	23,500	5,300	700	51,100
Brunswick	6	2	2	6	5,000	300	1,500	5,000	10,000	----	----	16,500
Camden	3	2	3	1	----	----	----	----	----	----	----	----
Carteret	10	4	4	3	530	----	----	----	----	----	----	----
Chowan	4	3	4	----	----	----	----	----	----	----	----	----
Columbus	14	12	15	27	10,440	1,200	6,000	17,600	15,000	500	150	39,100
Craven	9	4	7	7	500	----	----	----	----	----	----	----
Cumberland	11	4	5	7	300	200	1,000	2,000	2,500	----	----	5,500
Currituck	5	3	4	1	2,000	----	----	----	----	----	----	----
Dare	5	3	4	5	30	20	100	350	900	----	----	1,350
Duplin	5	10	10	31	7,100	5,300	26,500	70,200	42,600	1,000	600	140,300
Edgecombe	14	7	8	26	3,000	5,000	25,000	11,000	13,700	500	120	50,200
Gates	7	4	5	4	----	----	----	----	----	----	----	----
Greene	9	5	6	6	350	20	100	2,000	3,000	500	----	5,600
Halifax	12	7	8	66	40	----	----	----	----	1,000	180	1,000
Harnett	13	9	11	23	28,660	100	500	8,200	9,500	500	100	18,700
Hertford	6	3	4	----	----	----	----	----	----	----	----	----
Hoke	8	1	1	2	5,000	----	----	----	----	----	----	----
Hyde	5	3	6	----	----	----	----	----	----	----	----	----
Johnston	17	9	11	19	400	60	300	2,000	2,000	200	100	4,500
Jones	7	3	4	14	6,500	580	2,900	12,600	22,500	1,400	150	39,400
Lenoir	12	5	5	14	600	20	100	2,400	5,000	2,000	200	9,500
Martin	10	3	3	2	150	----	----	300	100	----	----	400
Nash	15	10	12	15	1,400	20	100	2,000	18,600	----	150	20,700
New Hanover	5	----	----	----	----	----	----	----	----	----	----	----
Northampton	9	6	8	4	1,220	----	----	1,300	300	----	30	1,600
Onslow	5	3	6	7	3,500	40	200	2,200	5,000	1,000	30	8,400
Pamlico	5	4	4	----	----	----	----	----	----	----	----	----
Pasquotank	6	3	5	----	----	----	----	----	----	----	----	----
Pender	10	4	6	13	400	----	----	5,050	----	----	----	5,050
Perquimans	5	3	3	----	----	----	----	----	----	----	----	----
Pitt	12	7	9	12	1,600	500	2,500	3,100	7,500	5,400	200	18,500
Richmond	7	4	6	19	5,000	200	1,000	1,800	5,300	4,400	90	12,500
Robeson	25	12	13	10	2,300	20	100	2,500	3,000	----	----	5,600
Sampson	16	6	8	22	5,700	400	2,000	7,200	8,000	1,800	600	19,000
Scotland	4	1	2	----	----	----	----	----	----	----	----	----
Tyrrell	5	4	4	1	----	----	----	----	----	----	----	----
Washington	4	3	10	6	10,000	40	200	----	10,000	----	----	10,200
Wayne	12	5	6	5	330	20	100	5,700	----	----	----	5,800
Wilson	10	3	5	----	----	----	----	----	----	----	----	----
Totals	385	201	256	412	122,000	15,000	75,000	182,000	210,000	26,000	3,400	493,000

While the area burnt is an increase over 1917 it is considerably less than the average of the past six years. The number of fires is also less. The total damage reported was far below the two succeeding years and less than two-thirds of the average.

FOREST FIRES DURING THE YEAR 1919

The fire seasons of 1919 were on the whole short and not severe. The spring fire season began about the middle of March and ended about the middle of May. However, the month of April was showery and only a few fires occurred, chiefly toward the latter part of the month. May was showery over the greater part of the State, though fires occurred in some places. The Federal Patrolmen were appointed the last week in March and the first week in April. All but one, who was in an especially dangerous district, were taken off duty the middle of May.

The fall fire season began in September, which was exceedingly dry. However, as killing frosts did not occur until November, except in the high mountains, there was little danger from fires previous to this date. From November 1 until December 6 the weather was dry, but occasional showers greatly reduced the number of serious fires. There was little danger after December 6, although the last week in December was dry and some fires occurred even then. Five Federal Patrolmen were appointed the second week in November, the sixth one having been put on October 15. They had all ceased work by December 16.

TABLE 5.—FOREST FIRES IN NORTH CAROLINA DURING 1919

SUMMARY OF REPORTS FROM CORRESPONDENTS BY COUNTIES

Mountain Region

COUNTY	Total Number of Townships in County	Number of Townships Reporting	Number of Replies Received	Number of Fires	Total Number of Acres Burned Over	Merchantable Timber Destroyed, M.	Value of Timber Destroyed	Value Young Growth Destroyed	Value of Products Destroyed	Value of Improvements Destroyed	Cost of Fire Fighting	Total Damage Reported
Alleghany	7	6	7	3	20	10	$ 50	$ 50	$......	$......	$....	$ 100
Ashe	15	8	12	2	20	....	....	....	....	200	......	200
Avery	8	3	4	2	10	....	....	....	....	100	......	100
Buncombe	18	7	12	16	1,000	110	550	1,400	500	150	550	2,600
Burke	13	5	8	13	2,000	60	300	10,500	7,500	600	100	18,900
Caldwell	12	9	21	22	1,300	70	350	2,200	800	50	120	3,400
Cherokee	6	2	5	51	7,000	100	500	8,000	1,000	300	200	9,800
Clay	5	4	8	32	2,100	140	700	8,400	5,000	600	170	14,700
Graham	3	2	4	20	4,600	210	1,050	2,100	5,000	850	300	9,000
Haywood	13	8	12	26	1,200	210	1,050	2,500	7,000	650	800	11,200
Henderson	8	7	14	16	2,200	50	250	9,400	4,450	500	100	14,600
Jackson	15	9	11	75	3,900	20	100	4,400	11,000	300	180	15,800
Macon	11	10	12	22	1,700	120	600	2,500	1,000	500	110	4,600
Madison	16	11	19	12	10,200	220	1,100	6,800	25,000	1,100	270	34,000
McDowell	11	7	8	16	5,500	100	500	11,900	....	1,300	50	13,700
Mitchell	10	6	8	6	500	300	1,500	10,000	50,000	300	100	61,800
Polk	6	6	12	18	3,600	160	800	9,400	6,800	....	500	17,000
Rutherford	14	9	14	61	2,600	510	2,550	15,050	13,200	1,200	270	32,000
Surry	14	14	35	71	1,900	270	1,350	22,450	25,300	2,100	120	51,200
Swain	4	2	2	9	2,000	200	1,000	14,000	10,000	3,000	600	28,000
Transylvania	8	6	8	22	13,200	3,000	15,000	25,000	20,000	5,500	500	65,500
Watauga	13	7	12	1	10	....	....	....	2,000	....	......	2,000
Wilkes	21	18	38	22	1,100	310	1,550	3,200	1,550	1,700	160	8,000
Yancey	11	9	14	24	340	30	150	750	2,900	....	200	3,800
Totals	262	175	300	562	68,000	6,200	31,000	170,000	200,000	21,000	5,400	422,000

TABLE 6.—FOREST FIRES IN NORTH CAROLINA DURING 1919

SUMMARY OF REPORTS FROM CORRESPONDENTS BY COUNTIES

Piedmont Region

County	Total Number of Townships in County	Number of Townships Reporting	Number of Replies Received	Number of Fires	Total Number Acres Burned Over	Merchantable Timber Destroyed, M.	Value of Timber Destroyed	Value of Young Growth Destroyed	Value of Products Destroyed	Value of Improvements Destroyed	Cost of Fire Fighting	Total Damage Reported
Alamance	14	8	13	3	10		$	$ 50	$ 50	$	$	$ 100
Alexander	8	5	6	7	20			100	100		10	200
Anson	8											
Cabarrus	12	6	7	20	10			300	600	100	20	1,000
Caswell	9	5	6	12	20			100	50		10	150
Catawba	8	5	8									
Chatham	13	5	6	9	90	20	100	600	500	1,000	70	2,200
Cleveland	11	6	13	2	20			500				500
Davidson	17	13	16	5	20			200				200
Davie	7	4	6	3	20			100	1,000			1,100
Durham	7	5	6	6	350				200			200
Forsyth	14	9	13	9	50			500	150	750		1,400
Franklin	10	4	5									
Gaston	6	3	4	1	300			600			10	600
Granville	9	6	8	11	100	20	100	800	1,000		100	1,900
Guilford	18	11	13	14	100	80	400	600	500			1,500
Iredell	16	5	11	1	30	10	50	200	500	100		850
Lee	7	2	6	9	10	20	100	50	500	50	250	700
Lincoln	5	3	6	1								
Mecklenburg	15	9	11	26	20			100		50	10	150
Montgomery	10	8	15	29	16,900	240	1,200	26,200	11,600		600	39,000
Moore	9	4	5	20	10,300			1,500	2,200	800	150	4,500
Orange	7	4	5	2	100			200				200
Person	9	4	6									
Randolph	20	13	23	34	700	120	600	4,600	1,500	1,300	150	8,000
Rockingham	11	9	11	3	30	10	50	1,500	1,000			2,550
Rowan	14	6	13	10	220			600	200	1,300		2,100
Stanly	10	5	7	12	40	10	50	300	250			600
Stokes	9	5	7	11	700	60	300	3,000	2,500	700	600	6,500
Union	9	6	8									
Vance	9	4	5	1	50			1,000				1,000
Wake	19	10	14	10	720	10	50	10,600	5,300	1,050	20	17,000
Warren	12	6	8	4	20			500	100	200		800
Yadkin	9	7	13	12	50			200	200	1,600		2,000
Totals	371	205	304	287	31,000	600	3,000	55,000	30,000	9,000	2,000	97,000

TABLE 7.—FOREST FIRES IN NORTH CAROLINA DURING 1919

SUMMARY OF REPORTS FROM CORRESPONDENTS BY COUNTIES

Coastal Plain Region

COUNTY	Total Number of Townships in County	Number of Townships Reporting	Number of Replies Received	Number of Fires	Total Number of Acres Burned Over	Merchantable Timber Destroyed, M.	Value of Timber Destroyed	Value Young Growth Destroyed	Value of Products Destroyed	Value of Improvements Destroyed	Cost of Fire Fighting	Total Damage Reported
Beaufort	6	5	8	51	1,600	180	$ 900	$12,600	$6,500	$11,000	$400	$31,000
Bertie	9	6	7	15	620	100	500	4,000	25,000	2,000		31,500
Bladen	15	6	8	14	12,000	1,200	6,000	19,000	7,500	500		33,000
Brunswick	6	1	1	1	1,000			400	500			900
Camden	3	1	2									
Carteret	10	3	4	4	1,500	20	100	6,200	1,200			7,500
Chowan	4	2	2									
Columbus	14	7	14	36	24,500	2,400	12,000	82,000	13,000	28,000	3,600	135,000
Craven	9	3	4	5	3,500	100	500	5,000	2,000	1,000	100	8,500
Cumberland	11	4	5	19	760	500	2,500	12,000	4,500	5,000	900	24,000
Currituck	5	2	3									
Dare	5	2	3	20	2,500	20	100	15,000	2,000			17,100
Duplin	13	3	3	18	2,000	60	300	15,000	9,000	500	2,500	24,800
Edgecombe	14	6	8	8	1,380	80	400	6,500	18,200	100	45	25,200
Gates	7	3	3									
Greene	9	3	3	2	30			500	500			1,000
Halifax	12	5	6	26	1,500	100	500	7,400	200	1,200	100	9,300
Harnett	13	11	15	26	25,800	20	100	12,300	25,600	7,000	100	45,000
Hertford	6	1	1									
Hoke	8	1	1	2	2,000			1,000				1,000
Hyde	5	4	7	8	21,300	1,000	5,000	1,000	10,000	1,000	500	17,000
Johnston	17	7	9	13	770	40	200	2,600	2,500	200	25	5,500
Jones	7	3	4	9	10,200	80	400	20,000	75,000	1,600		97,000
Lenoir	12	5	7	17	1,550	120	600	8,400	6,000	1,000	100	16,000
Martin	10	3	4	16	200			100				100
Nash	15	7	8	12	570			1,200		5,000		6,200
New Hanover	5	1	2	6	100							
Northampton	9	5	6	15	800			5,500	10,500	700	150	16,700
Onslow	5	2	3	5	100				100	100	10	200
Pamlico	5	2	2	1	1,000	100	500	2,000				2,500
Pasquotank	6	3	4									
Pender	10	6	7	31	14,800	10,560	52,800	14,000	28,000	2,500	300	97,300
Perquimans	5	1	1	5	300			1,500		1,500		3,000
Pitt	12	6	7	11	10			5,000	100	2,100	50	7,200
Richmond	7	6	8	33	11,900	120	600	7,900	8,000	2,000	50	18,500
Robeson	25	10	15	57	3,600	80	400	15,200	15,400	6,000	520	37,000
Sampson	16	7	8	18	5,650	40	200	3,000	300	500	50	4,000
Scotland	4											
Tyrrell	5	4	5									
Washington	4	3	4									
Wayne	12	6	9	4	230	20	100	1,500	2,400	500		4,500
Wilson	10	4	5	2	230	60	300	2,200	6,000			8,500
Totals	385	170	226	510	154,000	17,000	85,000	290,000	280,000	81,000	9,500	736,000

Although ten per cent less of the townships sent in reports in 1919 than the previous year there was a twenty-five per cent increase in the total area burned over. The increasing value of stumpage and consequently of young growth is seen in the great increase in the total damage reported, this amounting to $1,255,000, two-fifths of which is injury to young growth.

FOREST FIRES DURING THE YEAR 1920

There were no general severe or protracted fire seasons during 1920. The spring was cold and wet; at least two weeks later than normal. Farm operations were late so that the burning of brush and rubbish got delayed. Though occasional fires occurred in March—a large number in the Sandhills region—it was not until April that the wind and sun brought about more than ordinarily hazardous conditions and these were of short duration, owing to the heavy and well distributed rainfall. The peak of the season came from April 23-25, in the Mountain and Piedmont districts, and many serious fires occurred then. The fire season continued through May because of exceptionally light, though well distributed, rainfall, though before the end of the month all need for patrol was at an end. The first Federal Patrolman was appointed March 23 and at the last April 22. All but one were relieved of duty by the end of May.

The fall fire season was exceptionally late in commencing. There was no killing frost, even in the mountains, till October 2, and the first general killing frost occurred on October 29 and 30, which was unusually late. Most of the weeds and grass stayed green in the middle and eastern parts of the State till the middle of November. It is not till the leaves have fallen and the weeds and other vegetation become dry that there is any great danger from fire. This accounts for the lack of fire danger through October, which was exceptionally dry, only about one-quarter of the usual rainfall occurring. Two short dry spells occurred in November, one before the 11th and the other ending with general rains on the 28th; it was during this latter period that the worst fall fires occurred. There were periodic rains through December, yet a number of fires were reported. The patrol season lasted from about November 1 to the middle of December, when all but one of the Federal Patrolmen were laid off. The greater part of their time they were engaged in more or less educational work.

TABLE 8.—FOREST FIRES IN NORTH CAROLINA DURING 1920.

SUMMARY OF REPORTS FROM CORRESPONDENTS BY COUNTIES

Mountain Region

COUNTY	Total Number of Townships in County	Number of Townships Reporting	Number of Replies Received	Number of Fires	Total Number of Acres Burned Over	Merchantable Timber Destroyed, M.	Value of Timber Destroyed	Value Young Growth Destroyed	Value of Products Destroyed	Value of Improvements Destroyed	Cost of Fire Fighting	Total Damage Reported
Alleghany	7	6	9	4	6,200	1,020	$ 5,100	$91,000	$12,000	$ 6,200	$-----	$114,300
Ashe	15	9	15	6	20	--------	--------	100	200	200	------	500
Avery	8	6	8	41	2,500	160	800	6,400	2,100	300	300	9,600
Buncombe	18	10	21	29	2,510	100	500	6,050	250	600	250	7,400
Burke	13	5	10	10	400	--------	--------	600	--------	200	------	800
Caldwell	12	9	20	33	1,000	500	2,500	900	500	3,500	300	7,400
Cherokee	6	5	6	54	3,640	60	300	1,500	900	300	250	3,000
Clay	5	4	9	27	1,770	70	350	12,150	60,000	--------	900	72,500
Graham	3	2	3	26	1,150	20	100	750	850	100	70	1,800
Haywood	13	8	13	17	1,500	20	100	3,000	20,200	--------	600	23,800
Henderson	8	8	21	21	1,480	170	850	8,800	1,850	500	80	12,000
Jackson	15	7	10	69	6,210	10	50	450	600	400	50	1,500
Macon	11	6	9	29	1,110	--------	--------	2,000	1,300	--------	50	3,300
Madison	16	10	18	24	840	70	350	7,550	500	1,000	------	9,400
McDowell	11	10	13	35	8,100	90	450	16,450	1,800	600	200	19,300
Mitchell	10	5	8	2	900	400	2,000	19,800	3,000	1,000	200	25,800
Polk	6	4	11	14	1,110	30	150	4,250	700	--------	200	5,100
Rutherford	14	9	12	46	3,160	100	500	4,700	5,200	--------	------	10,400
Surry	14	11	23	25	2,420	480	2,400	20,100	1,300	6,600	50	30,400
Swain	4	3	4	19	4,800	30	150	7,300	3,050	300	400	10,800
Transylvania	8	6	9	57	1,270	80	400	1,750	550	--------	250	2,700
Watauga	13	10	18	34	670	60	300	3,350	8,050	3,300	470	15,000
Wilkes	21	19	41	23	3,280	920	4,600	11,800	1,100	400	80	17,900
Yancey	11	9	18	13	2,060	10	50	1,250	1,000	1,500	300	3,800
Totals	262	181	329	658	59,000	4,400	22,000	232,000	127,000	27,000	5,000	408,000

TABLE 9.—FOREST FIRES IN NORTH CAROLINA DURING 1920

SUMMARY OF REPORTS FROM CORRESPONDENTS BY COUNTIES

Piedmont Region

COUNTY	Total Number of Townships in County	Number of Townships Reporting	Number of Replies Received	Number of Fires	Total Number of Acres Burned Over	Merchantable Timber Destroyed, M.	Value of Timber Destroyed	Value Young Growth Destroyed	Value of Products Destroyed	Value of Improvements Destroyed	Cost of Fire Fighting	Total Damage Reported
Alamance	14	10	14	1	30	-------	$------	$ 500	$ 100	$------	$----	$ 600
Alexander	8	3	4	----	-------	-------	-------	-------	-------	-------	------	-------
Anson	8	2	2	6	550	30	150	10,200	50	-------	50	10,400
Cabarrus	12	8	12	29	210	40	200	3,600	6,200	4,200	250	14,200
Caswell	9	6	7	9	100	10	50	250	-------	-------	------	300
Catawba	8	5	7	4	40	20	100	200	1,000	-------	------	1,300
Chatham	13	6	6	17	200	10	50	6,150	3,700	5,000	50	14,900
Cleveland	11	6	14	14	100	-------	-------	300	600	-------	10	900
Davidson	17	10	15	5	170	-------	-------	800	200	-------	50	1,000
Davie	7	6	6	1	100	-------	-------	-------	300	-------	------	300
Durham	7	4	5	1	5	-------	-------	50	150	-------	------	200
Forsyth	14	8	12	3	30	-------	-------	150	50	-------	------	200
Franklin	10	4	4	4	130	20	100	1,500	5,500	1,000	------	8,100
Gaston	6	5	8	7	1,010	-------	-------	1,000	-------	-------	------	1,000
Granville	9	7	9	8	60	-------	-------	500	-------	-------	------	500
Guilford	18	7	8	5	30	10	50	550	-------	-------	------	600
Iredell	16	6	11	----	-------	-------	-------	-------	-------	-------	------	-------
Lee	7	3	4	9	200	-------	-------	600	-------	-------	------	600
Lincoln	5	4	9	----	-------	-------	-------	-------	-------	-------	------	-------
Mecklenburg	15	6	10	5	15	-------	-------	200	200	100	------	500
Montgomery	10	10	19	36	2,650	570	2,850	8,750	8,000	-------	30	19,600
Moore	9	8	48	109	25,000	160	800	44,200	200	4,800	1,000	50,000
Orange	7	4	5	3	40	50	250	950	-------	-------	50	1,200
Person	9	3	4	4	260	10	50	550	-------	-------	------	600
Randolph	20	14	26	34	370	170	850	1,200	250	300	50	2,600
Rockingham	11	9	17	14	90	50	250	2,150	1,500	-------	------	3,900
Rowan	14	6	11	14	50	-------	-------	400	300	-------	------	700
Stanly	10	6	8	8	20	-------	-------	100	-------	-------	------	100
Stokes	9	3	4	5	60	-------	-------	1,100	-------	-------	200	1,100
Union	9	6	7	3	-------	-------	-------	100	-------	-------	10	100
Vance	9	6	8	13	280	-------	-------	300	-------	-------	------	300
Wake	19	9	12	16	600	30	150	4,850	12,000	1,000	200	18,000
Warren	12	6	8	33	520	-------	-------	3,700	1,500	1,500	50	6,700
Yadkin	9	8	17	10	80	20	100	1,100	200	100	------	1,500
Totals	371	214	361	430	33,000	1,200	6,000	96,000	42,000	18,000	2,000	162,000

TABLE 10.—FOREST FIRES IN NORTH CAROLINA DURING 1920

SUMMARY OF REPORTS FROM CORRESPONDENTS BY COUNTIES

Coastal Plain Region

COUNTY	Total Number of Townships in County	Number of Townships Reporting	Number of Replies Received	Number of Fires	Total Number of Acres Burned Over	Merchantable Timber Destroyed, M.	Value of Timber Destroyed	Value Young Growth Destroyed	Value of Products Destroyed	Value of Improvements Destroyed	Cost of Fire Fighting	Total Damage Reported
Beaufort	6	1	1	32	400	100	$ 500	$1,000	$2,000	$5,000	$500	$ 8,500
Bertie	9	5	6	2	70	250	1,250	350	-------	-------	80	1,600
Bladen	15	7	9	5	1,110	150	750	1,550	2,000	-------	50	4,300
Brunswick	6	1	1	2	20	-------	-------	-------	-------	-------	-----	-------
Camden	3	1	2	----	-------	-------	-------	-------	-------	-------	-----	-------
Carteret	10	3	3	22	550	10	50	3,950	7,000	-------	-----	11,000
Chowan	4	2	4	2	40	-------	-------	200	-------	-------	-----	200
Columbus	14	9	14	56	12,000	300	1,500	8,100	5,600	3,400	800	18,600
Craven	9	4	6	14	1,000	100	500	500	-------	-------	100	1,000
Cumberland	11	7	9	6	3,320	300	1,500	2,000	300	-------	100	3,800
Currituck	5	3	4	----	-------	-------	-------	-------	-------	-------	-----	-------
Dare	5	3	5	4	80	10	50	-------	50	-------	-----	100
Duplin	13	4	5	13	1,280	110	550	9,350	2,000	1,000	100	12,900
Edgecombe	14	7	11	10	930	20	100	3,400	2,200	-------	-----	5,700
Gates	7	4	4	----	-------	-------	-------	-------	-------	-------	-----	-------
Greene	9	3	3	2	50	-------	-------	300	-------	-------	-----	300
Halifax	12	6	6	4	70	-------	-------	50	50	-------	10	100
Harnett	13	9	14	14	16,580	160	800	11,000	1,900	1,800	200	15,500
Hertford	6	3	4	----	-------	-------	-------	-------	-------	-------	-----	-------
Hoke	8	3	3	6	2,100	160	800	1,800	200	-------	10	2,800
Hyde	5	3	8	3	1,500	100	500	1,000	1,000	-------	500	2,500
Johnston	17	9	14	26	150	-------	-------	800	1,100	25,000	10	26,900
Jones	7	4	4	6	50	-------	-------	1,000	2,000	25,000	-----	28,000
Lenoir	12	2	2	4	500	10	50	50	-------	-------	-----	100
Martin	10	4	5	6	600	10	50	1,650	3,000	10,300	-----	15,000
Nash	15	3	3	2	520	-------	-------	1,100	-------	-------	-----	1,100
New Hanover	5	----	----	----	-------	-------	-------	-------	-------	-------	-----	-------
Northampton	9	6	8	35	600	20	100	200	-------	100	30	400
Onslow	5	3	3	11	4,000	10	50	1,000	150	100	-----	1,300
Pamlico	5	----	----	----	-------	-------	-------	-------	-------	-------	-----	-------
Pasquotank	6	6	8	----	-------	-------	-------	-------	-------	-------	-----	-------
Pender	10	6	8	82	10,300	30,100	150,500	15,100	70,500	300	300	236,400
Perquimans	5	2	2	1	100	-------	-------	-------	-------	-------	-----	-------
Pitt	12	5	8	8	1,540	20	100	27,000	2,000	-------	-----	29,100
Richmond	7	7	10	47	6,850	560	2,800	11,200	8,700	2,700	200	25,400
Robeson	25	9	16	34	2,820	300	1,500	38,400	5,300	500	100	45,700
Sampson	16	7	19	18	5,300	480	2,400	12,500	21,000	6,200	260	42,100
Scotland	4	4	4	17	3,450	100	500	20,100	112,500	1,500	100	134,600
Tyrrell	5	2	3	2	30	-------	-------	1,000	-------	-------	-----	1,000
Washington	4	2	3	18	20,000	-------	-------	10,000	-------	-------	550	10,000
Wayne	12	5	8	2	30	10	50	100	450	-------	-----	600
Wilson	10	5	5	3	60	10	50	250	1,000	100	-----	1,400
Totals	385	179	253	519	98,000	33,400	167,000	186,000	252,000	83,000	4,000	688,000

Although only slightly more than half the townships in the State reported in 1920, yet there was a decided increase in the number of forest fires; but this is counterbalanced by the very gratifying reduction in

area burnt over. In spite of this reduction the total reported damage mounted up to last year's figure, or $1,258,000, only very little below the average for the six-year period.

REVIEW OF THE PAST THREE YEARS

Looking back over the past three years we see a gradual increase in the total number of fires and also in the total damage reported. The former is probably due to more careful reporting and attention to the small fires rather than to any actual increase. The latter may undoubtedly be attributed to the gradual rise in the stumpage value of timber and the growing realization that young growth has a very real actual as well as prospective value.

The patrolled areas, of which unfortunately there were very few, had a less number of fires and showed a marked diminution in the total damage per fire.

TABLE 11.—FOREST FIRES IN NORTH CAROLINA

SUMMARY OF REPORTS FROM CORRESPONDENTS BY REGIONS FOR THE THREE YEARS 1918, 1919, AND 1920

Mountain

	1918	1919	1920	Average for Six Years
Total number of townships in region	262	262	262	262
Number of townships reporting	181	175	181	187
Number of replies received	351	300	329	333
Number of forest fires reported	416	562	658	606
Total area burned over, in acres	56,000	68,000	59,000	102,000
Total standing timber destroyed in M. feet board measure	4,000	6,200	4,400	12,400
Value of timber destroyed	$ 20,000	$ 31,000	$ 22,000	$ 54,000
Value young growth destroyed	85,000	170,000	232,000	146,000
Value forest products destroyed	150,000	200,000	127,000	130,000
Value improvements destroyed	5,000	21,000	27,000	24,000
Total damage reported	260,000	422,000	408,000	355,000
Cost to private individuals to fight fires	2,700	5,400	5,000	8,200

Piedmont

	1918	1919	1920	Average for Six Years
Total number of townships in region	371	371	371	371
Number of townships reporting	218	205	214	214
Number of replies received	333	304	361	323
Number of forest fires reported	308	287	430	383
Total area burned over, in acres	26,000	31,000	33,000	34,000
Total standing timber destroyed in M. feet board measure	2,000	600	1,200	2,100
Value of timber destroyed	$ 10,000	$ 3,000	$ 60,000	$ 16,000
Value young growth destroyed	55,000	55,000	96,000	59,000
Value forest products destroyed	15,000	30,000	42,000	36,000
Value improvements destroyed	23,000	9,000	18,000	15,000
Total damage reported	103,000	97,000	162,000	126,000
Cost to private individuals to fight fires	1,700	2,000	2,000	2,300

TABLE 11.—FOREST FIRES IN NORTH CAROLINA—CONTINUED

SUMMARY OF REPORTS FROM CORRESPONDENTS BY REGIONS FOR THE THREE YEARS 1918, 1919, AND 1920

Coastal Plain

	1918	1919	1920	Average for Six Years
Total number of townships in region	385	385	385	385
Number of townships reporting	201	170	179	198
Number of replies received	256	226	253	266
Number of forest fires reported	412	510	519	563
Total area burned over, in acres	122,000	154,000	98,000	224,000
Total standing timber destroyed, in M. feet board measure	15,000	17,000	33,400	48,000
Value of timber destroyed	$ 75,000	$ 85,000	$ 167,000	$ 181,000
Value of young growth destroyed	182,000	290,000	186,000	255,000
Value forest products destroyed	210,000	280,000	252,000	349,000
Value improvements destroyed	26,000	81,000	83,000	97,000
Total damage reported	493,000	736,500	688,000	882,000
Cost to private individuals to fight fires	3,400	9,500	4,000	10,600

State

	1918	1919	1920	Average for Six Years
Total number of townships in region	1,018	1,018	1,018	1,018
Number of townships reporting	600	550	574	599
Number of replies received	940	830	943	922
Number of forest fires reported	1,136	1,359	1,607	1,552
Total area burned over, in acres	204,000	253,000	190,000	360,000
Total standing timber destroyed, in M. feet board measure	21,000	23,800	39,000	62,500
Value of timber destroyed	$ 105,000	$ 119,000	$ 195,000	$ 251,000
Value young growth destroyed	322,000	515,000	514,000	460,000
Value forest products destroyed	375,000	510,000	421,000	515.000
Value improvements destroyed	54,000	111,000	128,000	136,000
Total damage reported	856,000	1,255,000	1,258,000	1,363,000
Cost to private individuals to fight fires	7,800	16,900	11,000	21,100

SIZE OF FIRES

The Federal Government in reporting forest fires has for some years classified them according to their area. The proportion of small fires to large should eventually be a good index of the efficiency of the forest fire warden system. Fires will occur as long as careless people are allowed to go near the woods and permitted to carry matches; but if such fires can be prevented from becoming large fires, damage will be reduced to a minimum. The following table (No. 12) is based upon the Federal Forest Service classification, in which "A" fires are less than one-fourth acre in extent; "B" fires are from one-fourth acre to ten acres in extent; and "C" fires are ten acres and over in extent.

TABLE 12.—CLASSIFICATION BY SIZE OF FOREST FIRES IN NORTH CAROLINA DURING THE THREE YEARS 1918, 1919, AND 1920, IN PERCENTAGES

	Mountain	Piedmont	Coastal Plain	State
A	17	26	15	18
B	26	37	26	29
C	57	37	59	53

PROGRESS OF PROTECTION

Although the greater proportion of the fires are no doubt included in these reports, still many fires in the aggregate must occur in those townships for which no reports are received. The total number of fires reported, therefore, cannot be used as an indication of accomplishment in forest protection. A much more reliable index of the results of the publicity and educational work done and the progress of forest fire prevention is furnished in the average damage reported per acre burned over and the average area of each fire reported. The following table shows the gradual though not very regular trend of values in an upward direction through the past twelve years and the gradual and decided reduction in the average area of the forest fires reported.

TABLE 13.—SHOWING INCREASE THROUGH TWELVE-YEAR PERIOD IN AVERAGE DAMAGE PER ACRE BURNED OVER AND DECREASE IN AVERAGE AREA OF EACH FIRE

	Average Damage per Acre Burned Over—Dollars		Average Area of Each Fire Reported—Acres	
	Annual	Three-year Period	Annual	Three-year Period
1909	$ 0.66		668	
1910	.97	$ 1.48	594	493
1911	2.80		217	
1912	1.76		926	
1913	2.18	1.99	587	658
1914	2.03		462	
1915	1.20		358	
1916	3.73	3.40	442	290
1917	5.26		70	
1918	4.20		180	
1919	4.56	5.13	181	160
1920	6.63		119	

CAUSES OF FOREST FIRES

The portion of the annual reports from correspondents dealing with the causes of forest fires is perhaps the most interesting part of the whole report, because it is in a way a study of the mental attitude of the population of the different parts of the State towards forest fires, and incidentally towards many other live problems. Perhaps the most remark-

able feature of the following table is its close similarity to the table printed on page 27 of Economic Paper, No. 48, published in 1918, showing the causes of fires for the previous three-year period.

The average for the past six years, as seen in Table 13, is very little different from three-year average given in the above report.

TABLE 14.—CAUSES OF FOREST FIRES IN NORTH CAROLINA

AVERAGES FOR THE THREE YEARS 1918, 1919, AND 1920, AND FOR THE PAST SIX YEARS IN PERCENTAGES

Causes	Mountain				Piedmont				Coastal Plain				State			
	1918	1919	1920	Average for Six Years	1918	1919	1920	Average for Six Years	1918	1919	1920	Average for Six Years	1918	1919	1920	Average for Six Years
Brush burning	24	20	18	24	34	36	40	37	27	22	27	23	27	24	27	27
Hunters	12	13	12	13	13	11	7	8	9	13	6	9	11	12	12	11
Campers	1	4	7	3	4	3	3	3	1	3	2	2	2	4	4	3
Railroads	12	19	11	14	17	18	18	20	17	17	19	18	15	19	18	17
Lumbering	20	4	19	13	6	6	12	9	22	12	12	16	17	8	14	13
Incendiary	11	10	6	7	2	2	5	3	4	8	5	6	6	8	5	6
Lightning	----	1	----	1	1	1	1	1	2	1	1	1	1	1	1	1
Miscellaneous	2	2	7	3	8	4	7	6	4	4	6	5	5	3	7	4
Unknown	18	27	20	22	15	19	7	13	14	20	22	20	16	21	12	18

Forest fires caused by brush burning still lead in number and importance. These fires will continue to be most numerous until forest wardens can be placed all over the State, so that they can come into contact with every rural resident and gradually train them to be more careful in handling fire. The same excuse is nearly always given, namely that the fire was thought to be out but was really left before it was out and a wind coming up in the afternoon or the next day fire was blown out to the woods.

There is a slight increase in incendiary fires which may be due to the apparent increase in illicit distilling in the State. Several correspondents mentioned this as a cause for forest fires. One correspondent reports from Henderson County: "We have one or more fires each year back in the mountains, without doubt set by blockaders to hide their smoke. We have so far failed to catch them in the act." From Wilkes and Chatham counties also fires are reported which were probably set by "moonshiners."

Another cause for incendiary fires has been ranging cattle in free range territory. One correspondent in Jackson County, who apparently thinks it advisable to burn the woods as a help to the pasture, says "most all of the fires are caused by stock rangers to keep down filth (namely, undergrowth.)" A correspondent from Craven County writes: "It is in the free range or no fence district that most of our fires occur. The trifling negroes (in most districts it is not confined to the negro race)

that own a few starved cattle set fire to the dry grass in the woods or cut-over lands so that their cattle may be able to get at the first sprigs of grass that get an inch high. If we could get stock law that would practically eliminate our forest fires."

The Survey and the North Carolina Forestry Association have been strongly advocating State-wide stock law for many years, realizing that the free ranging of cattle was a fruitful source for forest fires. Now that the Legislature has passed this measure and cattle and hogs can no longer run at large, many of these fires will cease, and the cut-over lands will have a better chance of coming back to profitable pine timber.

Amongst the causes of fires classed as miscellaneous, perhaps the most frequent is carelessness with matches, cigars, cigarettes, pipes, etc. A correspondent from the Sandshills region writes: "We have more forest fires from people riding along the roads. One striking a match lights his cigar and throws the match out on the side of the road—this is one chance of a fire. He then throws out the stub when through smoking, which is another chance of a fire from the same match. Most of our fires start along the public highway."

Recently an automobile load of men drove up in front of the State Forester's residence to take on a passenger and in two or three minutes a fierce fire was discovered burning in the leaves by the side of the road. The weather was dry and the wind high. In a few minutes more the fire might have been beyond control and much damage done. Undoubtedly this fire was set by the carelessness of a man throwing away a match or cigar stub.

Children playing with matches is another fruitful source of forest fires. One of the most destructive fires reported from the mountain region during 1920, causing some $50,000 damage, was caused from "children played they were burning off tomato beds. The weather was very dry and the wind high." Another fire in Duplin County was caused by children playing with matches at a schoolhouse. Parents and teachers should emphasize the danger not only to the woods but to the children themselves through playing with matches.

Another cause of fires, classed as miscellaneous, is catching out from the open fire near the spring, which is used with the weekly wash. The wash usually has to be done on a certain day in the week whether or not the wind is high and the leaves dry. It would be much better to postpone the wash for a day rather than set fire to the woods. However, by making a closed fireplace under the wash-pot such danger could be practically eliminated.

LAWS AGAINST BURNING THE WOODS

After the passage of the Forest Fire Law by the General Assembly of 1915, little forestry legislation was enacted until the winter of 1921. In 1919, however, an amendment to the Revisal was passed which in

many parts of the State may have an excellent effect in preventing the setting of unlawful fires. It was first published as chapter 318 of the Public Laws of 1919, but is now incorporated in the Consolidated Statutes of North Carolina, as the last sentence of section 4309, chapter 82: It reads as follows:

"Any person who shall furnish to the State evidence sufficient for the conviction of a violation of this statute shall receive the sum of twenty dollars to be taxed as part of the court costs."

The section mentioned above, to which the amendment has been added as a last sentence, refers to "setting fire to grass and brush lands and woodlands" and corresponds with section 8 of the forest fire law, chapter 243, Public Laws of 1915. For the convenience of the general reader the State Law against burning the woods is here given in its new form, for the Consolidated Statutes now takes the place of the Revisal of 1905 and the earlier Code.

INTENTIONAL FIRES

Section 4309. **Setting fire to grass and brush lands and woodlands.** If any person shall intentionally set fire to any grass land, brush land or woodland, except it be his own property, or in that case without first giving notice to all persons owning or in charge of lands adjoining the land intended to be fired, and without also taking care to watch such fire while burning and to extinguish it before it shall reach any lands near to or adjoining the lands so fired, he shall for every such offense be guilty of a misdemeanor and shall be fined not less than ten dollars nor more than fifty dollars, or imprisoned not exceeding thirty days. This section shall not prevent an action for the damages sustained by the owner of any property from such fires. For the purposes of this section the term "woodland" is to be taken to include all forest areas, both timber and cut-over land, and all second growth stands on areas that have at one time been cultivated. Any person who shall furnish to the State evidence sufficient for the conviction of a violation of this statute shall receive the sum of twenty dollars to be taxed as part of the court costs.

CARELESS AND ACCIDENTAL FIRES

Section 4311. **Setting fire to woodlands and grass lands with camp-fires.** Any wagoner, hunter, camper or other person who shall kindle a camp-fire or shall authorize another to kindle such fire, unless all combustible material for the space of ten feet surrounding the place where such a fire is kindled has been removed, or shall leave a camp-fire without fully extinguishing it, or who shall accidentally or negligently by the use of any torch, gun, match, or other instrumentality, or in any manner whatever, start any fire upon any grass land, brush land or woodland, without fully extinguishing the same, shall be guilty of a misdemeanor, and upon conviction shall be punished by a fine of not less than ten dollars nor more than fifty dollars, or by imprisonment not exceeding thirty days. For the purposes of this section the term "woodland" is to be taken to include all forest areas, both timber and cut-over land, and all second growth stands on areas that have at one time been cultivated.

FIRES MUST BE WATCHED CAREFULLY

Section 4312. **Certain fires to be guarded by watchmen.** All persons, firms or corporations who shall burn any tar kiln or pit of charcoal, or set fire to or burn any brush, grass or other material, whereby any property may be endangered or destroyed, shall keep and maintain a careful and competent watchman in charge of such kiln, pit, brush or other material while burning. Any person, firm or corporation, violating the provisions of this section shall be punishable by a fine of not less than ten dollars nor more than fifty dollars, or by imprisonment for not exceeding thirty days. Fire escaping from such kiln, pit, brush or other material while burning shall be *prima facie* evidence of neglect of these provisions.

A local law (section 4310) against "wilfully or negligently setting fire to woods and fields," referring only to the counties of Caldwell, Wilkes, Watauga, Burke, McDowell, Yadkin, Cherokee and Mitchell, allows one-half the fine to go to the informer, if there be one.

FOREST PROTECTION IN NORTH CAROLINA

Although the Forest Fire Law of 1915 provides the machinery for appointing wardens "in each township of the State in which the amount of forest land and the risks from forest fires shall . . . make it advisable and necessary," no appropriation was made for carrying out these provisions. The State Geological and Economic Survey has, therefore, had to depend upon its own limited funds and upon the small apportionment, amounting to some $2,000 annually, made by the Federal Government to the State for the payment of Federal Patrolmen. It was only possible to employ a few wardens and patrolmen from these available funds, and efforts have been made to secure additional funds through coöperation with associations of landowners and with lumber companies.

FEDERAL PATROLMEN

Under the terms of the agreement, the funds contributed by the Federal Government, under the Weeks Law, must be spent by the State for salaries of patrolmen and lookouts. The money has, up to this time, been paid direct from Washington to the patrolmen themselves upon certification of the State Forester. The amount has generally been apportioned in such a way that there has been less to spend in the spring when the need for it is greater and more in the fall when the fire season is usually shorter. This arrangement, which has tended to restrict the usefulness of the fund, is now being changed, making the use of the money more elastic.

The following statement gives the names of the Federal Patrolmen and the duration of their appointments through the spring and fall fire seasons during the past three years.

FEDERAL PATROLMEN, 1918

District	Name	Duration of Appointment	Total Days
Black Mountain	G. W. Stepp	Mar. 5–May 10	66
		Nov. 1–Nov. 30	30
Linville	E. R. Green	Mar. 13–May 30	78
	John Green	Oct. 22–Dec. 10	49
Mount Mitchell	W. L. Ward	Nov. 1–Dec. 21	51
Tryon	James F. Berry	Mar. 7–May 31	85
	Lawrence Doubleday	Nov. 11–Dec. 10	29
Wilkes	U. A. Miller	April 25–May 30 (daily basis)	17

FEDERAL PATROLMEN, 1919

District	Name	Duration of Appointment	Total Days
Black Mountain	D. E. Walker	April 10–May 15	35
Clay	Ed. T. Shearer	Mar. 24–May 14	52
		Nov. 10–Dec. 15	36
Linville	George F. Blair	April 7–May 14	38
		Nov. 6–Dec. 12	37
Moore	William R. Rice	Nov. 21–Dec. 20	30
Mount Mitchell	W. L. Ward	Mar. 29–May 31	64
		Oct. 15–Dec. 15	61
Tryon	James F. Berry	Mar. 24–May 14	52
	Wilkie Capps	Nov. 10–Dec. 15	36
Wilkes	C. H. Colvard	April 3–May 16	74
		Nov. 10–Dec. 15	36

FEDERAL PATROLMEN, 1920

District	Name	Duration of Appointment	Total Days
Black Mountain	Garland V. Stepp	Nov. 1–Dec. 24	53
Clay	Ed. T. Shearer	April 12–May 31	49
		Oct. 19–Dec. 16	58
Linville	George F. Blair	April 22–May 31	39
		Nov. 3–Dec. 8	35
Mount Mitchell	C. L. Wilson	April 5–May 26	51
Moore	William R. Rice	Mar. 12–May 12	61
Surry	L. B. Murray	April 21–June 2 (daily basis)	27
		Nov. 15–Dec. 17 (daily basis)	21
Tryon	James F. Berry	Mar. 23–May 31	69
		Nov. 8–Dec. 18	40
Wilkes	C. H. Colvard	April 1–May 20	50
		Nov. 1–Dec. 17	47

STATE FOREST WARDENS

In addition to those forest fire districts looked after by Federal Patrolmen the following five in the middle and eastern part of the State have been organized and partially patrolled by State Forest Wardens.

District	Forest Warden	Postoffice
Southern McDowell	George F. Rhom	Vein Mountain.
Western Rutherford	J. W. Hardin	Rutherfordton, R. F. D.
Western Montgomery	R. M. Bruton	Wadeville.
Southern Sampson	R. M. Pearson	Clinton, R. F. D.
Southern Columbus	W. C. Gore	Clarendon.

A number of other districts will be organized during the spring of 1921.

A badge like above cut, showing the State Geological and Economic Survey throwing its protective band around the young shortleaf pine tree, is furnished to all State Forest Wardens, who are required to wear it at all times when on duty.

INSTRUCTIONS TO STATE FOREST WARDENS

By W. D. CLARK, *Chief Forest Fire Warden*

HOW FOREST FIRES DESTROY COMMUNITY VALUES

The total land area of North Carolina is approximately thirty-one million acres, of which about two-thirds, or twenty million acres, at the present time, are devoted to forest growth. About one-fifth (four million acres) of the total forest area burned over during the decade 1910 to 1920, causing a property damage conservatively estimated at ten million dollars.

Such figures offer a sad commentary upon the manner in which we take care of an invaluable natural resource. The word invaluable is used in this connection, for who can correctly value all the indirect benefits which result from a healthy forest growth upon our mountain slopes and other non-agricultural land? The damage figures given above include simply the average market value of the products destroyed. As a matter of fact, the loss is much more than the value of these products for when fire consumes a farm woodlot no less than when it consumes a large timbered tract, it destroys a source of employment for local residents, and for teams. especially during the winter period, when other work is slack. It destroys local supplies of lumber for building and manufacturing purposes and of wood for fuel. It necessitates the importation of such products from more distant points and additional

charges for freight and hauling of the same. The lack of local supplies of lumber is sure to drive away all sorts of industries which depend upon local wood supplies for their raw materials. This in turn reduces the local population, for it reduces local demand for labor. The reduction of population reduces local land values and destroys the local market for farm products as well as other products.

The value of the land is reduced in another way by fire, in that the productivity of the land is reduced. Every ground fire, no matter how light, burns up a greater or less amount of humus, which is nature's chief enriching element. This in turn drys out the soil and makes it more liable to erode and wash away. Thus, surface run off during rains is accelerated and deep seepage diminished. During periods of prolonged drought springs and streams, especially in mountainous country, are apt to go dry and during periods of heavy rainfalls they rush in torrents carrying along all manner of detritus. This is either deposited in the river channels lower down, where it obstructs navigation or the detritus is spread over fertile flood plains destroying their agricultural value. Fire destroys the beauty and general recreational value of the woods. It drives away the birds and all other wild life of the forest. It diminishes the value of the area burned as a cattle range. Although it may cause green shoots of grass to spring up in the early season it also reduces the vitality of the roots to spread and produce vigorously for the remainder of the season and kills entirely many other kinds of herbs which are desirable cattle food. This may all be summed up by saying that forest fires destroy a balance of nature as well as a balance of industry. They can and should be eliminated, or at least greatly reduced and controlled.

HOW FOREST FIRES MAY BE REDUCED IN SIZE AND FREQUENCY

Any form of wealth is worth protecting to the extent of its value. Insurance companies as a rule are quite willing to insure various forms of property to the full extent of their value and the rates they charge for such insurance bears a direct relation to the risk involved. The practice of issuing insurance on standing timber or young forest growth has never been developed to any very great extent in this country, although the proposition has been agitated more or less. One serious obstacle to such development has been the prohibitive rate which the great risk necessitates. In other words, the chances are so great that standing timber or young forest growth will be destroyed by fire that no insurance company is willing to carry the risk except at so high a rate that the owner cannot afford to pay it. The reason why insurance rates on town and city property are so low is that efficient efforts are made to prevent fires and also to stop fires quickly when they do break out. Comparatively little has been done so far either to prevent forest fires from breaking out or to extinguish them quickly when they do break out. Vigorous

efforts along both of these lines must be made. If frame structures are worth protecting against fire, surely the source of supply from which all timber is derived should be protected against fire. The idea that forest fires are inevitable; that they are bound to occur; that they do not do much damage any way, and who cares, must all be counteracted. As a matter of fact, the ultimate cause of practically all of our serious forest fires lies in just such ideas. It is almost a self-evident truth that every one of us, all the way from our wooden cradle or wicker basket which receives us at our birth to the wooden coffin in which we are buried after death, is a beneficiary both directly and indirectly of the forest. If every one of us could be thoroughly convinced that forest fires are a wilful waste; that they are not inevitable; that most of them are the result of rank carelessness; that it is no less than a crime to carelessly permit one to start; and furthermore, that it is an urgent public duty for every one who sees a fire or hears of one to do everything reasonable within his or her power to help to extinguish it, or at least to report it at once to those whose duty it is to extinguish it; then and not until then will the loss from forest fires become merely nominal.

The establishment of these facts is an educational process. The minds of our children constitute the most fertile soil for the reception of the seed. The lesson should, therefore, be taught in the schools. Sunday schools, likewise, might very properly take it up, for as forest fires are a wilful waste to that extent it becomes immoral not to stop them. The daily press and all widely distributed periodicals should help to spread the idea. It should be propagated by the moving-picture houses, thrown out from the lecture platform and pulpit and by all other disseminators of beneficial ideas.

Along with the dissemination of the idea must go the development of an organization and the acquisition and placement of equipment necessary to do the actual work required in the prevention, control and extinguishment of the fires. Good men, efficient and well organized, are needed and, likewise, good equipment. Ultimately every township should have at least one forest warden and more according to its needs. Every group of townships, perhaps every county, should have its supervising warden and every group of counties should have its district warden. These should all be headed up by a State Warden, whose duty it would be to supervise the whole organization.

Every member of this organization should be accessible by telephone, especially during dry and dangerous periods for one of the secrets of success in any fire-fighting organization is to get reports of fire as soon as it breaks out in order to get to it with a crew and equipment and fight before it gains headway. Good equipment is just as essential as good and well organized men. Good soldiers are of little use without good arms and ammunition. Likewise a good forest-fire organization is of

little help without good equipment. Such equipment would include axes, saws, rakes, shovels, hoes, buckets, torches, and in some instances chemical fire extinguishers and light auto trucks. The equipment should all be located so as to be accessible quickly whenever it may be needed. It would include a system of watch towers and cabins, located on high points, from which watchers could survey a wide expanse of territory and detect fires by the rising smoke as soon as they start. All cabins and towers should be connected by telephone lines and also with the forest wardens' headquarters, so that they could receive notifications of fires immediately. In this connection recent inventions in wireless telephone and telegraph systems are very promising, for if the expense of installing and wire connections can be eliminated communications between inaccessible places will be greatly facilitated. It would be the duty of the warden, upon receiving notice of a forest or grass fire within his territory, to gather a crew and necessary tools and go to the fire as quickly as possible and extinguish it. The wardens should have authority to commandeer help, when it is necessary, in order to extinguish a fire and the State should pay those commandeered a reasonable sum for their time and labor.

Such a forest protective system cannot be developed overnight. It grows and develops from small beginnings. A little development here and a little development there, then union and organization, until the entire forested area of the State is covered by a single, closely coöperating organization. In other words, organized coöperative effort should be built up and substituted for disorganized individual effort. Every forest warden in the State has an opportunity to perform a very important and necessary part of such development and he may take considerable pride and satisfaction in all that he is able to accomplish towards that end.

The war on forest fires is on in earnest. The battle line extends from the Atlantic to the Pacific and from the Canadian boundary on the north to the Gulf and Republic of Mexico.

That this demon of the forest is bound to come under subjection is as certain as the subjection of the malaria-carrying mosquito or yellow fever, once the cause and effect and means of subjection is known.

Forest fires are one of the outstanding signs of inexcusable inefficiencies and insufficiencies of our age. They can and should be stopped: If we become pessimists and confirmed in the belief that the world is on the slip-slide and doomed to the bow-wows—then so be it! If we, or the majority of us, continue to be optimists and firm in the belief that the battle against all well known and flagrant inefficiencies is to be continued, then the unalterable laws of progress will be granted another vindication and progress will progress.

"Where there is a will there is a way." As the will has not been sufficiently spurred to action so the way has not been developed.

The way includes efforts directed first to prevention of fires; second to the quick detection of the fires that are not prevented, before they gain headway, in order that they may be reported quickly to regularly appointed agents whose duty it will be to extinguish them.

First prevention, next detection, followed by extinguishing, this covers in a nutshell what must be done. Carelessness and wilfulness is the cause of nine-tenths of our forest fires. The underlying cause of the wilfulness is mostly ignorance as to the nature and extent of the damage done but in some cases the wilfulness is due to pure and unadulterated cussedness. The attempt must be made to carry the lesson of the forest fire in some way to every man, woman and child in the State. They must be convinced and their support enlisted. Without such universal support and coöperation all the United States Army and all the United States Navy could not stop these fires. With such support the forest fire problem would already be solved.

In remote sections the forest wardens and patrolmen must carry the message to every dweller in his district.

Carelessness in letting fire escape and wilfulness in setting out fire should be penalized. Experiments demonstrate that a small fine for carelessness on the part of a negro in the use of fire is very conducive to future care. Conditions in Mountain Sections are very different from conditions in Coastal Plain Sections and this includes human as well as physical factors. In Coastal Plain Sections many advocate controlled burning of the forests in the winter time in order to avoid the risk of accidental burning in the dryer times. This idea should be given fair trial. The burning of fire lines along railroads, highways, and elsewhere will be effective.

The North Carolina Geological and Economic Survey is increasing its activity in urging all forest landowners to organize and substitute concerted effort for individual effort in fighting this common enemy of the forest.

During their recent session the members of the Legislature recognized the importance of this work and made a small increase in the appropriation for carrying it forward. In order to make this money go as far as possible in developing coöperative effort on the part of the smaller owners the Director of the Survey offers to pay from funds appropriated for this purpose one-half of the expense of employing forest fire wardens to work in the more dangerous sections providing the property owners will bear the other half of the expense. As the most dangerous part of the season rarely lasts for more than two or three months the expense involved is not large and when shared by the average number of owners in a tract of one hundred thousand to two hundred thousand acres it is not a heavy burden and the insurance thus obtained is exceedingly cheap.

In sections where forest protection is especially urgent, but for

various reasons it is exceedingly difficult for the small owners to get together on a coöperative basis, the Legislature at their last session provided another possibility for coöperative effort between boards of county commissioners and the North Carolina Geological and Economic Survey, whereby the county bears one-half of the expense of employing a forest warden and the State bears the other half. In other words, the State proposes to help those who help themselves and those who wish to take advantage of such opportunities should apply to Colonel Joseph Hyde Pratt, Director, whose office is at Chapel Hill, N. C.

It should be pointed out that State funds for the above purposes are strictly limited and the principle of "First come, first served" must be applied.

The gradual development of public support for more efficient protection of our forests against fire is very encouraging, for if only fire is kept out, our cut-over areas reforest themselves by natural methods very rapidly. In all sections of the State, where concerted efforts are being applied, results clearly demonstrate that most of the forest fires can be prevented, that all of these that are not prevented can be quickly extinguished if those who see it first do their duty and report it at once to officials whose duty it is to see that it is extinguished. It has been equally well demonstrated that wherever inflammable material exists fires are likely to break out and that wherever it is customary to let them burn themselves out incalculable damage is done. That an efficient organization to prevent and extinguish the fires is by far the cheaper method is beyond the peradventure of a doubt.

A large force of local patrolmen and forest wardens are needed to do educational work amongst the country people. Many of them do not realize at all the great damage done by fire, not only to the forest growth, but also the soil fertility. In fact, it is not at all uncommon to find that they firmly believe that fire is a good thing not only for the forests but also for grazing purposes and so they set the woods on fire every year. I have recently learned that in some sections cotton growers set adjacent woods a-fire because they believe that the boll weevil propagates in the woods from which it later launches its attack on the cotton fields. The bootleggers and illegal distillers also frequently set the woods on fire in order to make a smoke screen to hide their outlaw distilling operations. If these outlaws could be driven out of business by severe penalties many of our forest fires would cease. A large amount of educational work must be carried on to reduce the number of fires started by both ignorance and carelessness and an efficient organization must be developed to enforce the forest laws and direct the fire-fighting crews where fires break out. If these measures are carried out the damage done by such fires will be reduced to a minimum.

CAUSES OF FOREST FIRES

Matches, Cigarettes, Cigars, Pipes.—Most of these forest fires are due to pure carelessness on the part of those who use the forest. Such carelessness includes the throwing of burning matches, cigarettes, cigars or pipe contents into dry leaves or dry grass. Such an act may be done by a man hunting or merely tramping through the woods, or it may be done by one riding in an automobile along a country road, or by a man on horseback. The fire does not start at once. Probably the one who thoughtlessly threw away the match or cigarette is out of sight when the smouldering fire breaks into flame. This flame may just creep along until it crosses a field, then enters an adjacent woods where there is considerable dry underbrush, or slash. When this catches fire severe burning and great damage result. Perhaps the man who started it has reached home several miles away. Nobody saw him throw away the burning cigarette that started the fire and he, himself, never realizes that it was his act of carelessness that started a forest fire which did thousands of dollars worth of damage before it was finally extinguished.

Camp-fires.—A similar act of carelessness is the leaving of a camp-fire of any kind before it is thoroughly extinguished. A breeze starts up after the party has left, it fans the smouldering embers into a flame, sparks are carried by the wind to dry grass or leaves near by, from which another severe forest fire starts and the members of the camping party never realize that it was their act of carelessness that started the fire.

Sawmills.—But it is not always some one bent on pleasure that starts these unnecessary fires. The operator of a sawmill may permit a mass of scattered inflammable material to collect around his mill. A spark from the engine or some other source sets it on fire and it quickly gets beyond control.

Logging Roads.—A logging operator may permit the locomotives which haul the log trains to scatter sparks among the slash along the line of the logging railroad. During the dry season many forest fires are started in this way and perhaps a whole mountain side burned over every year as long as the logging operation continues.

Railroads.—The section foreman of a passenger and freight railroad may neglect to clean up properly along their right of way before the dangerous dry season sets in and as a result fires start along this right of way.

Brush Burning.—The farmer sets fire to brush to clear new land and because he does not use necessary precautions the fire gets away from him and burns over all of his neighbors' lands.

Range Burning.—The stock man sets fire to the grass land and lets it run wherever it will for his own selfish reasons.

All Unnecessary Fires Should Be Eliminated.—All of such sources of forest fires can and should be eliminated. In fact, the only cause of

forest fires which cannot be eliminated is lightning and this source is rarely the cause of any considerable damage because they occur while it is raining and the fire is soon extinguished by the rain.

DUTIES OF THE FOREST WARDENS

Watch Sources of Fires.—It is the duty of forest wardens to watch carefully all sources of forest fires and to keep accurately informed as to where the forest fires originate in their district. Whenever they see dangerous conditions which are liable to cause fire they should warn the owners of the property and advise them how to reduce the fire hazard by cleaning up the inflammable material in their vicinity.

Post Notices.—When on patrol duty wardens should always carry with them a supply of notices issued by the North Carolina Geological and Economic Survey. They should also provide themselves with a suitable tack hammer and tacks for posting securely. Roofing nails should be used for posting on trees. Tacks are not long enough to hold. Nail them down to stay. Do not hang them up. Every district must be thoroughly posted. This means that at least one notice be posted at some gathering place in every town or village. The bulletin boards of county courthouses, postoffices and the general village store are good places to post. Permission to post should always be asked and permission will rarely be refused if the reasons for posting are properly explained. Notices should also be posted at proper intervals along highways or trails commonly traveled through the forested sections, and especially at picnic grounds, springs, or other gathering places in the forests.

Interview Residents.—The farmers and other residents in a forested section should be visited and informed of the measures the State and National Governments are taking to prevent and extinguish forest fires. The forest laws should be explained to them and they should be convinced as to the harm forest fires do to their community. They should be made to realize that it is their public duty to coöperate with the State officials in both preventing and extinguishing forest fires. They should be cautioned against the careless use of fire in burning brush or clearing land and informed of the State laws providing a penalty for carelessly allowing any sort of a fire to escape from their property on to their neighbors'.

Visit the Sawmills, Logging Operations, Tar Kilns, Charcoal Pits, Tanning Plants and All Other Wood-using Industries.—These are the industries whose business it is to harvest and manufacture the products of the forests. The life of these industries depends on a continuous supply of these products. For this reason the owners and officers in charge of them should be vitally interested in preventing forest fires from burning up their source of supply. As a rule, they will be found to be practical and capable business men and will be glad to give you

valuable advice and suggestions as to how to work up local sentiment for preventing forest fires. It is the duty of wardens to coöperate with those in control of such industries to the greatest extent. If they do not seem to be interested try to learn why they are not and report their objections and criticisms to this office.

Railroads.—Practically all surface fires originating along railroad lines can be stopped effectually if sufficiently wide strips parallel to the railroad are cleared of all inflammable material before each spring and fall fire season sets in. It is the general custom of railroad companies to do this to the extent of their own right of ways. As their right of ways usually extend about fifty feet from the outside rail on both sides of the track this strip, even when thoroughly cleared, is not wide enough to catch all sparks thrown out by the locomotives. As the railroad companies have no right to clear beyond their right of way all abutting property owners should be urged to clear an additional strip one hundred to two hundred feet wide and parallel to the railroad line. The distance to which the sparks from the engines fly depends on the rise and fall of land from the track and exposure to wind. Where conditions permit a ploughed strip six furroughs wide and two hundred feet back from the outside rail will stop all surface fires originating from locomotives under ordinary conditions, providing it is kept clear of inflammable material. If the strip between the furroughs and the railroad is burned over once each year additional safety is secured.

Visit Schools.—Every school in the official's district should be visited at least once a year. Arrangements should be made with the teacher or superintendent for such a visit. If the official has ability in addressing children the teacher will no doubt be glad to give him an opportunity of talking to the pupils about how trees and forests reproduce themselves and how necessary it is to protect especially the young trees from fire in order that they and future generations of children may be provided with lumber to meet their future needs. It would also be worth while to show the children the leaves and fruit of different species of trees and teach them how to distinguish one from the other. The indirect benefits of the forests should also be mentioned, such as protection to birds and wild animals, prevention of soil erosion, equalization of the flow of rivers, preservation of springs and picnic grounds. If the official, himself, does not care to address the children, he should tell the teacher what he knows about trees, forests, forest fires, lumbering, State laws, etc., and request the teacher to talk to the children about them.

Patrol.—All wardens should patrol their entire districts according to directions during the dry and dangerous periods. Certain sections will be more liable to burn than others and these should be worked more thoroughly and more frequently. When patrolling is on a daily basis it is especially ordered that only such days be selected for patrol duty during which forest fires are likely to break out. Rainy days or damp

and wet days must not be selected for patrol duty. In some sections the danger is particularly great on Sundays and holidays and patrol should be made on such days when conditions call for it.

They should report fires at once to landowners, superintendents of estates, railroad agents, logging operators, lumbermen, etc., as soon as they are discovered. When necessary they can go to the assistance of such owners and help to extinguish the fires. In general, however, the owners are expected to protect their own land. The State has not yet made any appropriation to be used in extinguishing forest fires. But all officials can and should instruct owners in proper and efficient methods of fire prevention and fire fighting.

In most parts of the State especially dangerous conditions prevail from November till January and from March till May. These periods are prolonged or shortened according to climatic conditions and ground cover. In the eastern sections of the State conditions frequently remain in a dangerous condition throughout the dormant season of vegetation; that is, from the fall of leaves until the reappearance of leaves in the spring. Forest Wardens are directed to be especially active and watchful during the dangerous periods but they should consider that they are the State's duly authorized agent to prevent, extinguish, investigate and report upon forest and grass fires at all times. They should keep this office informed as to when dangerous conditions begin to prevail and also when they terminate. In other words, they should consider that they are on duty at all times, but as sufficient State funds are not available for continuous employment every effort should be made to apply such funds as are available when and where they will be most effective.

Badges Must Be Worn.—Forest Wardens are expected to wear at all times when on duty the badge furnished them by the State Forester. In this way the public will soon come to know and respect your authority, and your presence at any gathering will immediately remind people of their duty to be careful with fire. Care must be taken not to lose the badge, as it might come into the hands of unauthorized persons, who would use it for improper purposes. Wardens are responsible for the loss of a badge and will be charged one dollar for a new badge to replace the lost one.

Warnings Must Be Emphasized.—As in all other matters, so in the matter of forest fires, an ounce of prevention is worth more than a pound of cure. Your very first and most vigorous efforts must be to prevent forest and grass fires from breaking out. Your chief method must be by continually warning your people of the liability of fire breaking out whenever and wherever conditions become inflammable. Bear in mind at all times that a forest fire is rarely safely out before a following heavy rain. Therefore, it should be carefully patrolled until all danger of its breaking out again is passed. Always warn your people of this danger. As your chief weapon is *warning,* use it freely.

Police Powers.—All State Forest Wardens will be furnished with copies of the State Forest laws. They should study these carefully and become thoroughly familiar with all their provisions. Forest Wardens are given power to arrest without warrant persons detected in the act of unlawfully setting out forest fires, carelessly allowing forest fires to escape on to neighbors' land or tearing down or mutilating State notices, which they or other State officials have posted. They are cautioned to use this power with great discretion. If the arrest can just as well be made by regular authorities it is better that they should do it, the warden swearing out the warrant and appearing as a witness when advisable.

It is the duty of all Forest Wardens to assist generally in the enforcement of all forest laws. When breaking of the forest laws becomes intentional and frequent they should first collect evidence necessary to convict the guilty party and then take steps to have the party brought before the local magistrate.

It is very important for the officials to endeavor to build up their good influence and gain the good will of their people by assisting them in every way possible in the work of forest fire prevention. They should carefully avoid antagonizing them in any way.

Make Daily Reports.—Forest Wardens must make out their daily reports promptly upon the forms furnished them. They should be mailed at their first opportunity. This means the first time they are in the vicinity of a postoffice and not four or five days later. It is very important that they write carefully and answer all questions asked, not merely one or two of them.

Make Special Report of Every Forest Fire.—Blank forms are furnished for making detailed reports on all forest fires. No forest fire is too small to be reported. The North Carolina Geological and Economic Survey wants every warden to make special efforts to ascertain the cause of every forest fire which occurs in his district throughout the entire year. Arrangements have been made to pay for the time and expenses necessarily incurred in properly investigating all such fires, even though they occur out of the regular fire seasons. Careful estimates should be made of the area burned and value of damage done. It should be realized that damage to young growth is by no means limited to the value of the trees killed. It may be five or six years before natural reseeding will take place and as a result there will be a loss of five or six years of growth in addition to the growth destroyed. Many trees that are not killed outright are badly scarred or otherwise injured so that their rate of growth is greatly reduced. The damage to the soil and to all other property values should be carefully estimated and included. Efficiency in making out complete and accurate fire reports is a fairly good indication of the efficiency with which other duties are performed.

Monthly Statement.—At the end of every month and at the termination of their period of service, when this occurs within the month, every Forest Warden should submit promptly a brief statement, giving the patrol dates and dates of various authorized items of expense, which were necessarily incurred in performance of duty and for which they are entitled to reimbursement. These may include automobile mileage, use of horse or mule, car fare, and sometime board and lodging, when night overtakes them at a distance from home and it would be obviously in the interest of their work to return the following day. Regular forms for a monthly statement of expenses are provided by the Survey and the Director will not authorize payment until these have been submitted in proper form.

Special Requests and Information.—All requests for report forms, envelopes, notices, etc., and all special reports on conditions and all requests for information and instructions, should be written on separate paper in the form of a letter and not on the back of report forms. In this way the matter will come to the attention of the proper parties at the head office more quickly and accordingly be more quickly attended to. Never allow your supply of report forms, notices, envelopes, etc., to become exhausted. Be sure to request more as soon as your supply is small.

A general spirit of coöperation and helpfulness will always be appreciated by those in charge and it will greatly assist in efficient development of all forest protection work.

Our watchword is "Reduce the frequency and size of forest fires."

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

FORESTRY DIVISION

WEEKS LAW

FOREST FIRE PREVENTION

IN CO-OPERATION WITH THE FOREST SERVICE, UNITED STATES DEPARTMENT OF AGRICULTURE

CHAPEL HILL, N. C.

Circular Letter: April 8, 1921.

REWARD FOR EVIDENCE

SUPPLEMENTARY INSTRUCTIONS TO FOREST WARDENS

DEAR SIR:—The question has come up as to who is entitled to the reward of $20, authorized by section 4309 of the Consolidated Statutes, for furnishing to the State sufficient evidence to convict any party for setting fire to the woods. This must be decided by the magistrate trying the case. It should be understood, however, by all forest wardens that they are employed and paid by the State, among other things, to enforce the laws against burning the woods. For this reason, forest wardens cannot claim this reward, as it is their duty to furnish all evidence in their possession without any reward. I feel sure that this is generally understood, but this letter may prevent some misunderstanding in the matter.

Very truly yours,

(Signed) J. S. HOLMES, *State Forester,*

North Carolina Geological and Economic Survey.

COOPERATION IN FIRE PROTECTION

With the increase of the appropriation of the Survey, made by the Legislature of 1921, and an additional apportionment of Federal funds, after the first of July, it will be possible to still further extend the forest fire protective work of the Survey. The total amount available, however, will be far from sufficient to adequately protect all the townships that really need protection, so that the policy of appointing wardens where financial coöperation can be secured will be continued.

COUNTY COÖPERATION

In a State where local self-government plays such an important part as it does in North Carolina, it would seem as if some simple method should be in force to allow counties to initiate and take part in local protection from forest fires. A means to accomplish this has been provided by the General Assembly of 1921 in the form of an act (chapter 26), "To authorize counties to coöperate with the State in forest fire protection." The law is as follows:

AN ACT TO AUTHORIZE COUNTIES TO COÖPERATE WITH THE STATE IN FOREST FIRE PROTECTION

[CHAPTER 26, PUBLIC LAWS 1921.]

The General Assembly of North Carolina do enact:

SECTION 1. That the board of county commissioners of any county are hereby authorized and empowered, in their discretion, to coöperate with the North Carolina Geological and Economic Survey in the protection from fire of the forests within their respective counties, and to appropriate and pay out of the funds under their control for such protection an amount not to exceed one-half of the total expended by said Survey in such county during any one year for such protection: *Provided*, that said board of county commissioners may, in addition, agree with the Geological and Economic Survey to pay any part of or all the expenses incurred in extinguishing forest fires within said county after satisfying themselves that such expenses were legitimate and proper.

SEC. 2. All laws and clauses of laws in conflict with this act are hereby repealed.

SEC. 3. This act shall be in force on and after its ratification.

Ratified this the 9th day of February, A.D. 1921.

WHAT VIRGINIA HAS ACCOMPLISHED

Virginia has a similar law, and in 1916 the State Forester, who had then only recently been appointed, invited the county authorities to coöperate with him in the employment of one or more forest wardens for patrolling his county. Eight counties accepted the invitation that year and in 1919 the number had increased to twenty. In that year one county appropriated $300 for this purpose; three $250; one $200; four $150; one $125 (for fall only); eight $100; and two $75 each (for only part of the county).

In each county from one to four patrolmen were appointed under the agreement to pay at least half of their salaries either from State funds or from Federal funds which had been placed at the disposal of the State Forester. They were employed to work on dry days only during the dangerous seasons. These men, while on duty, spent their entire time traveling over the districts watching out for forest fires, posting warning notices, cautioning people to be careful with fires, visiting sawmills, etc.; in fact, doing exactly the same work as the forest wardens have been doing in North Carolina. As is the case in this State, they were given no authority to employ assistance in fighting fires, this being done in most cases by the local inhabitants. Suitable men were secured for around $3.50 per day, and out of this they paid any incidental expenses, such as feed for their horse, gas for their automobile and lodging, when it was necessary for them to stay out overnight.

Fire protection work along these lines has proven decidedly successful in Virginia. With the expenditure of a small county fund, covering not more than half the total cost of the men's salaries, fairly effective protection has been secured. "The patrolmen themselves," says the State Forester of Virginia, "are highly enthusiastic over the approval expressed by almost all citizens of their work and over the coöperation secured. It has been demonstrated that where there is serious fire danger a tremendous reduction in the forest fire loss can be brought about by this means at a cost that is trifling as compared with the damage that can be prevented. The method is undoubtedly right."

The boards of county commissioners in those counties where fire protection is most needed are being invited by the Survey to offer coöperation as was done in Virginia. As long as the available State and Federal funds hold out, the offers of coöperation will be carefully considered, and will be accepted, if mutually satisfactory arrangements can be made. The State is suggesting an agreement along the following lines:

PROPOSED BASIS OF AGREEMENT

PROPOSED BASIS OF AGREEMENT BETWEEN THE BOARD OF COMMISSIONERS OF .... COUNTY AND THE STATE GEOLOGICAL AND ECONOMIC SURVEY FOR THE PROTECTION OF THE FORESTS OF .... COUNTY FROM FIRE.

The Board of County Commissioners agrees:

1. To pay to the State Geological and Economic Survey one month before the beginning of the spring and fall fire seasons (February 1 and September 1) of each year the sum of $300 or more, to be covered by an equal or greater amount, both the county and State funds to be used for paying the salary (and necessary expenses) of one or more forest wardens in .... County.

2. To nominate and recommend to said Survey a suitable person or persons to act as forest warden or wardens in .... county, who must be men respected in their communities, of high character and of public spirit. They should own or have available a horse or automobile for use in patrolling.

3. To coöperate so far as is possible with said wardens, after they have been appointed in the execution of their duties and the enforcement of the forest fire laws.

The State Geological and Economic Survey agrees:

1. To employ and pay from funds at the disposal of the Survey one or more forest wardens in .... County.

a. Wardens to be employed on part time during the dry spring and fall fire seasons, and for extinguishing and investigating forest fires at other times.

b. Wardens to be appointed by State in accordance with State law.

c. Wardens to be paid by the Survey as soon as after the end of each month as final reports can be received, at a fair rate to be agreed upon between the warden and the Survey.

d. Wardens to be required to patrol during dry and dangerous weather, extinguish and investigate forest fires, post notices, interview residents, inspect sawmills, visit schools and other public places, and in general, work to prevent and extinguish forest fires. They will make necessary reports to the State Forester on forms provided by him.

2. To furnish to said wardens a badge of office, suitable notices for posting over the county and leaflets for distribution to landowners and other residents and users of the forests.

3. To submit an accurate account of all money paid to wardens in .... County to the Board of County Commissioners at the end of each year, showing how the money was expended and what amount was paid by the county, and what paid by the Survey.

If the cost of the forest fire prevention work in said county has not equaled or exceeded an amount equal to twice the amount appropriated by said county, the Survey will, upon request, return to said county its pro rata part of the fund remaining.

It is hoped that such coöperation can be started with a number of counties both in eastern and western North Carolina during the year 1921. Public opinion in most parts of the State is such that county commissioners will find the people behind them in making small expenditures for starting definite fire protection in their counties.

FOREST FIRE PROTECTIVE ASSOCIATIONS

The most effective coöperation in fire fighting has come from the several forest fire protective associations. These are not large organizations of big landowners, such as one finds throughout the Northwestern United States, but groups of small landowners and others, who are interested in the prevention of forest fires both for their own profit and the good of the community.

Four of these associations have been active in the suppression of fires for part or all of the three-year period under discussion, and though no very extensive work has been done their organization and encouragement by the State have been well worth while.

LINVILLE FOREST PROTECTIVE ASSOCIATION

This is the largest of the four associations, its membership representing some 33,000 acres of mountain land (See p. 55, Economic Paper No.

48). The interest of the members in its work has been fairly well sustained. The third annual meeting was held at Linville on September 27, 1918, when the following officers were elected for the ensuing year:

President, GEORGE W. HARDIN, General Manager, Linville River Railway Company, Johnson City, Tenn.

Vice-President, T. W. HAMPTON, Superintendent Boone Fork Lumber Co., Shulls Mills, N. C.

Manager, J. P. GIBBS, Linville Improvement Company, Linville, N. C.

Secretary, MR. VAN MATER, Linville Improvement Company, Linville, N. C.

Directors: George W. Hardin, T. W. Hampton, J. P. Gibbs; L. D. Ellis, Cranberry Iron and Coal Company, Cranberry, N. C.; E. G. Underdown, Manager, Cone Estate, Blowing Rock, N. C.

Owing to the absence of several members on war work and the absorbing interest of other activities related to the war, little development work was done. Fortunately, both the spring and fall fire seasons were practically free from dangerous periods and no large fires were reported. A few small fires along the railroad were extinguished without cost to the Association.

The report for 1919 shows that there were practically no fires during the year, the only expenditure for fire fighting being $5.00 in October. Those fires which did occur were caused by the railroad and in several cases were extinguished before spreading more than a few yards. Regular rains materially reduced the fire risk, and it was not deemed necessary to put out regular patrolmen.

At the annual meeting in 1919 the association area was divided up into six patrol districts, and in case of dangerous weather patrolmen will be employed to take the following routes:

(1) One going out on trains from Cranberry to Gap and walking back along track; (2) one following trains from Linville to Gap; (3) one patrolling Pineola and Grandmother Mountain; (4) one at Boone Fork; (5) one at Hodges Gap; and (6) one from Foscoe to Linville Gap.

During the year the association installed a protective telephone system from Poplar Siding to a point one mile beyond Linville Gap, a total distance of three miles. This line, in conjunction with the Linville Improvement Company's line, has 'phones at a number of points, including the railroad sidings, railroad station, Sanford & Treadway's office, Improvement Company's office, Davis's and Morton's. In case of alarm (which may be turned in day or night) a large number of fire fighters may be assembled at short notice. Fire fighting tools have been located in boxes at the following points:

West Linville Railroad Station,
Linville (Sanford & Treadway),
Linville Gap (Tate Davis's house),
Yonahlossee Road (Finley Gragg's).

At this same meeting it was explained that Andrew Calhoun had assisted several times in extinguishing forest fires, and in appreciation of his services the treasurer was instructed to pay him $5.

The constitution was amended to provide for seven directors instead of five. The following officers were then elected for the ensuing year:

President, T. W. HAMPTON, General Manager, Boone Fork Lumber Company, Shulls Mills, N. C.

Vice-President, F. M. ALLISON, Linville River Railroad Company, Cranberry, N. C.

Treasurer, L. D. ELLIS, Cranberry Iron and Coal Company, Cranberry, N. C.

Secretary-Manager, J. W. MORTON, Linville Improvement Company, Linville, N. C.

Directors: J. FRANK HAMPTON, General Manager Sanford & Treadway, Newland, N. C.

G. W. HARDIN, General Manager Linville River Railway Company, Johnson City, Tenn.

ED. ROBBINS, Pineola, N. C.

T. W. HAMPTON, Superintendent Boone Fork Lumber Company, Shulls Mills, N. C.

E. G. UNDERDOWN, Superintendent Cone Estate, Blowing Rock, N. C.

L. D. ELLIS, Cranberry Iron and Coal Co., Cranberry, N. C.

J. L. HARTLEY, Linville, N. C.

On motion the secretary was allowed $50 per year to pay for any necessary clerical help.

The manager's report for 1920 includes the following items:

"The year of 1920 did not require a great amount of action on the part of the Linville Forest Protective Association due to the fact that frequent rains greatly lessened the danger of forest fires. Therefore, there were no regular fire wardens engaged by the association, and the association was charged only for the time of the men engaged in putting out the few small fires that started.

"The expenses being low and balance on hand sufficiently large to more than meet the needs of the association, it was decided to postpone collection of annual dues until further funds were desired.

"Since all tools have been distributed to the various boxes, and telephone lines installed as planned, the following improvements are contemplated:

"(1) To provide the wardens with time clocks to make sure that they cover their territories thoroughly.

"(2) To enlist the interest of parties living in Blowing Rock and Shulls Mills in a telephone line between these two places to work in conjunction with the association.

"(3) To further perfect coöperation of the Linville River Railway, the Linville Improvement Company, and other landowners with the Linville Fire Protective Association, in regard to territories covered by their respective wardens and in getting fire fighters quickly to the scene of action.

"(4) To carry on a vigorous campaign to enlarge membership, thereby increasing protected territory and greatly lessening danger to the whole.

"The spirit of increased coöperation and interest shown by the people in the past year is very encouraging, and the association may hope for continued improvement."

The annual meeting of the directors of the Linville Fire Protective Association was held at Linville on November 3, 1920.

The motion was made and adopted that Mrs. Tate Davis be given the sum of $25 in recognition of her faithful services in vigilance and in fighting fires.

The motion was made and carried that the expenses of Mr. W. D. Clark, Chief Forest Fire Warden in the State Geological and Economic Survey, be paid by the association while engaged locally in securing additional members for the association.

Resolutions were adopted requesting the State of North Carolina to increase its appropriation for forest fire protection, in order to increase the Federal appropriation; petitioning the United States Congress to increase to one million dollars its appropriation under the Weeks Law; and requesting the United States Congress to adopt a permanent policy looking towards extensive acquisition of cut-over lands for national forests.

The financial report of the Linville Forest Protective Association, covering the past three years, follows:

FINANCIAL STATEMENT

1918

Jan. 1.	Balance on hand		$195.20
Dec. 31.	Semiannual dues from members		360.91
	Miscellaneous expenditures	$ 9.17	
Dec. 31.	Balance on hand	546.94	
		$556.11	$556.11

1919

Jan. 1.	Balance on hand		$546.94
Dec. 31.	By semiannual dues, July-Dec., 1919		336.41
May 19.	To back salary patrolmen	$ 40.00	
Oct. 24.	To expenses fire fighting	5.00	
Oct. 31.	To shovels and axe handles	31.13	
Nov. 6.	To three miles telephone wire	43.00	
Nov. 15.	To freight on wire	2.22	
Dec. 31.	To balance on hand	762.00	
		$883.35	$883.35

1920

Jan. 1. Balance on hand		$762.00
Paid for fire fighting, 1920	$ 46.00	
Making tool box	3.35	
Expenses of Chief Forest Fire Warden, securing members	24.50	
Salary of Secretary-Manager	50.00	
Dec. 31. Balance on hand	638.15	
	$762.00	$762.00

MOUNT MITCHELL FOREST PROTECTIVE ASSOCIATION

This association has continued its fire fighting work throughout the past three years with practically the same organization. Mr. A. R. Bauman, of Montreat, has been the secretary-manager, while Mr. Fred A. Perley, Black Mountain, has continued to act as president, and Mr. J. P. Parker, of Black Mountain, as vice-president. The activities of the association have been restricted to a small area, bounded on the east by the Blue Ridge, and on the west by the North Fork of the Swannanoa River.

The report for 1918 includes the following items:

On April 24 the manager wrote:

"While we have had several fires this season we have been able to handle them without much damage, and fires in general are much less frequent than in former years. We have had two fires on the Black Mountain watershed, both of which were extinguished by the Federal patrolman (who is coöperating with the association) with some assistance, our association paying for labor used in extinguishing these fires. We all feel gratified at the reduction of forest fires in our area."

On May 3 the manager reported:

"Tools have been sent to Mr. Fred Moser (Federal patrolman in Mount Mitchell District, adjoining the association on the north)."

On October 25 the manager reported:

"We have made our usual arrangements for the fire fighting season, and hope to be able to put on more patrols. We had quite a bad fire in Montreat and along the Perley & Crocket Railroad last week, and it took a good many men to extinguish it, costing about $65. The fire was along the entire length of the Perley & Crockett Railroad, where it goes through Montreat, and it went over to our watershed, doing much damage there. I am doing everything possible to keep such fires down, but owing to the very dry weather it was a hard job to check this one."

The report of this association for 1919 includes the following:

"We had about eleven fires in all during the season, most of which were small and easily extinguished without doing any material damage. Three of the fires burned over about three acres before being put out. These fires were caused by the Perley & Crockett Railroad engines, and were extinguished with the use of the potato rake and with brush. Owing to the lack of sufficient funds, we have been unable to do much constructive work other than to patrol and keep down these fires. There has been great improvement along this line, and we do not begin to have as many fires as in the past, because we are educating the people up to the importance of preserving the forests in general, and they are willing to assist in a moral way, though we have not been able to get them to assist financially.

"Much work in putting out fires is not charged for, as the people in general are always willing to assist in this work without any charge."

During 1920 the only fire fighting done by the association was in November. Several serious fires occurred and $126 was paid out for extinguishing them. The manager reports:

"All the fires we worked on during November were along the Perley & Crockett Railroad and set out by this road. These fires burned on Lookout, Brushy, Long Gap, Big and Little Slaty mountains, and also extended over on to the watershed of the Mountain Retreat Association, where this settlement gets its supply of drinking water. I would judge that over 200 acres were burned over."

Collections have been very slow in coming in during the past three years. Two or three of the more important members are contributing in a way by paying for fire fighting on their own land. There is also an understanding that some other members will contribute as soon as funds are exhausted. It is hoped that in this way the fire-fighting work of the association will be continued. Its patrol work has not been carried on for several years. It is expected that the logging railroad will be taken up within a year or two and then the association can be thoroughly reorganized or discontinued, as thought best.

The report of receipts and disbursements for the past three years follows:

FINANCIAL STATEMENT

1918		
Jan. 1. Balance on hand		$192.15
By dues and subscriptions		76.00
To labor, spring fire fighting	$112.95	
To expenses, secretary-manager	6.80	
Dec. 31. To balance on hand	148.40	
	$268.15	$268.15
1919		
Jan. 1. Balance on hand		$148.40
By dues and subscriptions		45.00
To labor, spring fire fighting	$ 3.50	
To labor, fall fire fighting	11.10	
To expenses, secretary-manager	10.00	
Dec. 31. Balance on hand	168.80	
	$193.40	$193.40
1920		
Jan. 1. Balance on hand		$168.80
By dues		10.00
To labor, fall fire fighting	$102.90	
To expenses, secretary-manager	23.40	
Dec. 31. To balance on hand	52.50	
	$178.80	$178.80

TRYON FORESTRY CLUB

Reports of the Tryon Forestry Club to the Survey have been meagre and irregular. This is in part due to the change in the management

made necessary by the illness and subsequent death of the former secretary, Mr. George B. Cobb, through whose earnest efforts the club was organized in 1911. The interest of the members in fire extinction has been sustained and their coöperation with the Federal patrolman of the district helpful.

The following statement, showing the number and character of fires occurring in the district over the three-year period indicates the success of their efforts:

Date	Area Burned Over	Total Damage	Cost of Extinguishing	Cause
1918:				
Feb. 26	40	$ 200	$ 3.95	From burning building.
March 15	75	150	13.50	Burning grass field.
21	4		.60	Hunters.
22	100	500	6.60	Incendiary.
30	2		.45	Railway.
Nov. 30	2			Railway.
Dec. 8	2			Bee tree.
1919				
April 14	6	50	3.30	Railway.
24	35	1,750	15.00	Railway.
24	50	750	15.00	Brush burning.
Nov. 23	40		5.40	Railway.
1920				
Mar. 23	35	175	21.80	Hunters.
April 25	79	1,000	23.60	Bee tree.
Nov. 19	500	2,500	148.20	Hunters.

Only one fire during the entire period exceeded 100 acres in extent, and the average fire was sixty-nine acres. This compares very favorably with the average for the State of 160 acres per fire and the six-year average for the State of 225 acres per fire. The average damage per fire reported by the Federal patrolman in this district, but in most cases estimated by the club, amounts to $7.30 per acre.

The following items have been reported by the officials of the club:

"The year of 1918 had damp weather both during the spring and fall fire seasons, with very few fires."

On April 24, 1919, the Treasurer writes:

"Had a call by 'phone from a man at Mill Springs, outside the area protected by the club, wanting help to put out the fires, which, of course, we could not give. At midday, a fire was reported near the Horse Shoe Curve (on the Southern Railway). The Federal patrolman, James F. Berry, was over on Green River, but we managed to get a force to the fire, and stopped it. Late this evening either the same fire or another one was burning on Piney Mountain, and we got another force out to it, but have not heard the result. Very dry, with high wind from the north tonight, so that it is almost impossible to control fires."

The annual report for the year 1919 shows Major Bernard Sharp, president; G. H. Holmes, treasurer; and B. C. von Kahlden, secretary, all of Tryon, N. C.

A total of 130 acres of land is reported as having been burned over during the year, about 35 of which is in Tryon Township and the balance in Saluda Township. An estimated damage of $20 per acre in timber and young growth is made. The treasurer writes:

"The fire season in the spring of 1919 was short, though very dry for a while. In the fall there was scarcely any dry weather when fires could do damage. The membership of the club is about forty."

The fire seasons for 1920 were short, and with one exception, not very serious. In November, however, during a brief windy dry time, a fire broke out on Tryon Mountain and lasted from 2 p.m., November 19, to 3 a.m., November 22, and burned over 500 acres. It would have been much larger but for the faithful work of the Federal patrolman, James F. Berry, who stayed with it the whole time. It is to be regretted that this faithful patrolman was shot and killed in Tryon on February 12, 1921. The State, the Federal Government, and the community have lost a faithful servant and citizen. The secretary reports that at the annual meeting on November 8, 1920, the following officers were elected:

W. T. Lindsey, President.
G. H. Holmes, Treasurer.
B. C. von Kahlden, Secretary.

The meeting adopted resolutions (a) calling upon the General Assembly to make adequate appropriations so that the State Geological and Economic Survey may greatly strengthen and extend its work for the prevention of forest fires in this State; (b) requesting Congress to continue the policy of acquiring lands for national forests and appropriating at least $10,000,000 a year for the next five years; and (c) requesting Congress to increase to one million dollars a year the appropriation for coöperation with the states in fire protection under the Weeks Law. The club decided not to charge membership fees, but to depend on voluntary contributions for necessary fire fighting funds.

The financial statement for the past three years is given below:

FINANCIAL STATEMENT

1918

Jan. 1.	Balance on hand		$ 65.22
Mar. 5.	To paid expenses fighting fire	$ 3.90	
Mar. 25.	To paid expenses fighting fire	2.20	
Nov. 20.	To paid expenses fighting fire	2.50	
Dec. 31.	To balance on hand	56.62	
		$65.22	$65.22

1919

Jan. 1.	Balance on hand		$ 56.62
	By dues and subscriptions		56.11
To paid labor fighting fires		$ 16.50	
Dec. 31.	Balance on hand	96.13	
		$112.73	$112.73

1920

Jan. 1.	Balance on hand		$ 96.13
	By dues and subscriptions		152.10
To paid labor for fighting fires		$183.80	
Dec. 31.	Balance on hand	64.43	
		$248.23	$248.23

SANDHILLS FIRE ASSOCIATION

After a number of conferences and correspondence extending over a number of years a fire protective association was organized in the center of the Sandhills region of the State, perhaps the most difficult region of the Eastern United States in which to control fires.

At a meeting held in Southern Pines on March 2, 1919, the Sandhills Fire Association was formed and the following by-laws adopted:

1. *Name.* The name of this association shall be the Sandhills Fire Association.

2. *Object.* The purpose of the association shall be for the proper and efficient handling of the woods fires in McNeills and Sandhills townships, in Moore County; and protection of said townships from fires arising in Hoke County.

3. *Area.* The activities of the association shall extend over such parts of McNeills and Sandhills townships in Moore County as it shall designate; and so much of the upper end of Hoke County as may be necessary for the protection of the above territory.

4. *Officers.* The association shall have the following officers: a chairman, whose duty shall as such consist solely in conducting the meetings; a secretary, whose duties shall be confined to acting as clerk of the meetings, conducting the correspondence and safeguarding all the papers of the association; a fire warden, whose duties shall consist of taking and having full charge of all the field activities of the association; a small committee to be selected by the warden to advise and assist him in such manner as he may designate. In the absence of the chairman from any meeting the members present shall choose a temporary chairman.

5. *Meetings.* The association shall hold its annual meeting on the first Saturday in December of each year, at which meeting the chairman, secretary, and fire warden for the ensuing year shall be elected. At said meeting reports shall be filed by all elective officers covering their work for the past year, which reports shall be filed with the records of the association. Other meetings shall be called from time to time by the secretary by the direction of either the chairman or the warden.

6. *Headquarters.* The headquarters of the association shall be in the town of Southern Pines.

7. *Membership.* The membership of the association shall consist of all adults in the district who shall sign the articles of association and pay the dues required.

8. *Dues and assessments.* The dues and assessments of the association shall be as follows: For all landholders, outside of the towns, at the rate of one-half a cent per acre per year; for all residents of the towns the rate shall be one dollar a year. All dues shall be payable in advance in half yearly installments on the dates of January 1 and July 1.

9. *Pledge.* It is further understood and agreed by and between the parties signing these rules that each one pledges and binds himself to coöperate with his neighbor for protection against fire at the call of his neighbor.

Mr. P. P. Pelton, through whose untiring efforts the association was formed, was elected secretary; and Mr. D. C. Lemons was requested to act as forest warden. He was subsequently appointed a State Forest Warden by the State Forester.

During that year the association was quite active in investigating fires and in prosecuting offenses against the forest fire laws. One case in particular, in which a prominent citizen had set fire to the woods to protect his own property and allowed fire to escape without any effort to control it, was hotly fought, but the man was convicted.

The association's efforts to interest the railroads of that region in preventing fires escaping from their right of way and extinguishing those resulting from sparks from their engines is bringing results. An effort to coöperate with the War Department in preventing the spread of fires from Camp Bragg, which adjoins the association property, brought out the fact that the War Department was taking strong measures to keep down fires on their property. The following letter was received by the secretary of the association:

HEADQUARTERS CAMP BRAGG,
Office of the Commanding Officer, FAYETTEVILLE, N. C., Dec. 4, 1919.
MR. P. P. PELTON,
Southern Pines, N. C.

DEAR SIR:—Replying to your letter of November 20th, we have a fire guard on Johnson Mountain looking out for fires in the reservation and the property adjacent thereto. The guard is there primarily to put out small fires in their vicinity, and to report to the camp commander any evidence of fires they cannot handle, in which case a detail of men would be sent out from camp as rapidly as possible to stop the fire.

The above precautions have been taken to protect the entire reservation. We have had no fires of any consequence on the reservation to date, and we hope you have been as fortunate.

(Signed) S. R. HOPKINS, *Lieut.-Colonel,*
Field Artillery, Executive Officer.

An effort was made to appoint a Federal patrolman to coöperate with the association in the spring of 1919 but no suitable man could be found until the fall, when William R. Rice, of Pinebluff, was appointed patrolman. He patrolled that fall and the next spring in a Ford truck and covered a large district, doing excellent work. Unfortunately, Mr. Rice has gone into other work and his services are not available. An attempt

to secure another suitable man in the fall of 1920 failed. Little has been done by the association during the past year, largely because the personal efforts of the secretary have had to be relaxed, owing to business reasons. There is a great opportunity for a live association in this region and it is hoped that the activities of the Sandhills Fire Association may be revived.

FINANCIAL REPORT FOR 1919 AND 1920

Receipts, 1919.		
By dues and subscriptions		$60.00
Expenditures, 1920.		
To lawyer's fee for prosecution	$20.00	
To fire fighting tools	5.50	
To re-charging chemical extinguisher	2.75	
To telephone tolls	1.00	
To miscellaneous expenses	3.11	
To balance on hand December 31	27.64	
	$60.00	$60.00
January 1, 1920.		
Balance on hand		$27.64
January 1, 1921.		
Balance on hand		27.64

WESTERN HARNETT COUNTY LANDOWNERS

As a result of an appeal for assistance in protecting their lands from fire made by some of the landowners in southwestern Harnett County late in the fall of 1920 the new Chief Forest Fire Warden visited the region and conferred with a number of prominent landowners. As a result of this, the Survey has made an offer to coöperate with the landowners without the formality of organizing a fire association. Pending the definite acceptance of this offer a fire warden, Mr. J. S. Johnson, Spout Springs, N. C., was appointed to start protection work and attempt to organize along the lines suggested in the following letter, which is given in full because it is thought other communities might like to receive the assistance of the State along similar lines:

CHAPEL HILL, N. C., November 30, 1920.

To the SUPERINTENDENT,
Highland Farm,
Pine View, N. C.

DEAR SIR:—Upon my return to headquarters I reported to the State Forester upon the practical efforts the landowners in your section of Harnett County are making to protect their forest lands against fire. I am very glad to be able to inform you that the Forester, on behalf of the State Geological and Economic Survey, is willing to authorize the appointment of a forest warden for duty in the western part of Harnett County and adjacent territory, the particular boundaries to be decided upon at a meeting of the interested parties. The basis of such authorization would be that the State pay 50 per cent of the salary and expenses of the appointee, and the associating landowners the

other 50 per cent. It would also be necessary to limit the total State expenditure for this work to $250 for the coming year. If the other coöperating parties could raise $250 this would make a total of $500, which should accomplish considerable in starting educational work, posting fire warning notices, and generally creating a public sentiment against uncontrolled forest fires.

The coöperating parties in this case would be the State, Mr. J. S. Johnson, yourself acting for Mr. Sprunt, Mr. Davis and Mr. Campbell, for the Overhills Club. No doubt Mr. E. G. Moss would want to come in for the Never Fail Farm, and perhaps you may think of others.

In order that this work may be started without unnecessary delay I am going to assume the privilege of asking you to call a meeting of the parties interested for the purpose of discussing these matters and arriving at some agreement.

Sometimes patrolmen are employed on a monthly basis with salary ranging from $75 to $90 per month and expenses at 75c a day for use of a horse; or 5c per mile for use of a car. They are employed for a month or two during the dangerous fall season and again during the spring season. Sometimes they are employed on a daily basis for from $3 to $5 a day and expenses, putting in three or four days a week.

The duties of the State forest wardens and Federal patrolmen would be chiefly as follows:

A. *Educational:*

1. To post in conspicuous places fire warning notices and essential parts of forest laws.
2. To distribute to interested parties copies of the State forest laws and other forest literature.
3. To call upon local residents, farmers, etc., and advise with them about the forest laws and caution them about the use of fire.
4. To visit the schools and teach the children how trees and forests reproduce themselves and how necessary it is to protect especially the young trees from fire in order that they and their children may be provided with lumber to meet their future needs.

B. *Patrol:*

1. To patrol their territory during the dry and dangerous seasons under the direction of the State Forester.
2. To report fires at once to landowners, to superintendents, to managers of local fire protective organizations, and to the State Forester.
3. To assist in preventing and extinguishing forest fires and in organizing and directing fire fighting crews.

C. *Police:*

1. To assist in the general enforcement of all forest laws.
2. To investigate and report upon the causes of forest fires and suggest improved methods of control.

The above is a general outline of forest warden duties. It would be of considerable help to us if you could bring these up for discussion at your meeting and let us have the benefits of your criticisms and suggestions.

The wardens should be nominated by the coöperators subject to the approval of the State Forester by whom the appointment would be made. The entire salary and expenses would be paid direct from the Survey office on submission of account supported by necessary vouchers. Then the Survey would submit all to the association which in turn would remit its half to the Survey.

It has been suggested that the cost of this forest protective work be distributed among the coöperating members on an acreage basis.

In order that a start may be made this year, we have written Mr. Johnson asking him to serve at State and Federal expenses for the first two or three weeks of December only.

We hope you will advise us how we may be of further assistance in this undertaking.

Very truly yours,

(Signed) W. D. CLARK, *Chief Forest Fire Warden,*
North Carolina Geological and Economic Survey.

PROTECTING MOUNT MITCHELL STATE PARK

When the General Assembly, at the urgent request of Governor Locke Craig, provided for the purchase of "a portion of Mount Mitchell, including the summit . . . for the creation of a public park," it did not make any provision for its administration or its protection from fire. Previous to November, 1916, when the purchase of the first 524 acres was completed, there had been no forest fires on the west slope of the area included in this purchase, but in the spring of 1917 two or three serious fires broke out. One of these killed some fifteen acres of the finest spruce and balsam timber on the park. It was from this burn that later some 200,000 feet of burnt timber was sold, and the money used for inaugurating fire protection.

Shortly after the occurrence of these fires, Governor Bickett requested the State Geological and Economic Survey to do what it could to protect this park from fire and from the damage to young growth being caused by some of the visitors. Since that time, until the present, the State Forester has had the actual supervision of the fire protective work on the park and has as far as he was able, on account of the shortness of funds, carried out a continuous policy of protection. With the appointment of a special commission to administer the park by the General Assembly of 1919, the responsibility was shifted from the Survey, but as the State Forester was made a member of the Commission the Survey's connection with the work was not severed and the policy which had been inaugurated was continued. The protection policy on the park has included the following measures, all of which have been carried out as far as the limited funds available have allowed.

The park has been placed in immediate charge of a forest warden, Mr. D. L. Moser, who lives close to the middle of the park practically the whole year. His chief duty throughout the dry spring and fall seasons and at other times when any fire danger exists is to patrol the park and the area which is being lumbered adjoining it. He travels along the railroad lines, visits the steam skidders, the logging crews and other places where engines and men are liable to set out fires. The need for this work is shown by the number of small fires set by sparks from engines which he has extinguished. During an excessively dry period last fall he reported that he had extinguished five such fires a day. In excessively dangerous seasons he has been assisted by an extra man.

As an additional precaution a strip 100 feet wide between the logged-over area and the live timber standing on the park is being cleared of the inflammable brush and tree tops as rapidly as money has become available It is hoped that this line can be completed during the present year. Already one or two fires burning in the slash would undoubtedly have destroyed a good deal of the live timber had it not been stopped by this fire line.

During the season when visitors and camping parties come to the park the warden makes a point of looking after camp-fires and cigarette smokers. Visitors are warned to be careful in the use of fire and requested to coöperate with the State in the protection of the park.

The General Assembly of 1921 has discontinued the commission appointed two years ago and transferred the care and management of the park to the State Geological and Economic Survey. The law, chapter 222, Public Laws of 1921, reads as follows:

AN ACT TO PROVIDE FOR THE ADMINISTRATION AND PROTECTION OF MOUNT MITCHELL STATE PARK.

The General Assembly of North Carolina do enact:

SECTION 1. That the North Carolina Geological and Economic Survey and the Geological Board shall exercise and perform all the rights, powers, duties and obligations that have been heretofore exercised and performed by the Mount Mitchell Park Commission and the Mitchell Peak Park Commission, and said Survey and Board shall be the lawful successor of said commissions; and upon the passage of this act, those portions of the acts establishing the Mount Mitchell Park Commission and the Mitchell Peak Park Commission are herewith repealed.

SEC. 2. That said State Geological Board be hereby further authorized and empowered to charge and collect fees for the use of such improvements as have already been constructed, or may hereafter be constructed on the Park, and for other privileges connected with the full use of the Park by the public; to lease for camps, houses, hotels and places of amusement and business; and to make and enforce such necessary rules and regulations as may best tend to protect, preserve and increase the value and attractiveness of the park.

SEC. 3. That all fees and other money collected and received by the State Geological Board in connection with its proper administration of Mount Mitchell State Park shall be used by said board for the administration, protection, improvement and maintenance of said park.

SEC. 4. That the State Geological Board shall make an annual report to the Governor of all money received and expended by it in the administration of Mount Mitchell State Park and of such other items as may be called for by him or by the General Assembly.

SEC. 5. That all laws and clauses of laws in conflict with this act are hereby repealed.

SEC. 6. That this act shall be in force from and after ratification.

Ratified this the 9th day of March, A. D. 1921.

The coöperation of the National Forest officers on duty to the east of the park has been secured, and telephone connection with them and with the Bell telephone at Marion has been made. The keeper of the

park can now communicate with most of the forest officials on the Boone National Forest and can when necessary connect with the general telephone system throughout the State. In addition to this a Federal patrolman, under the direction of the State Forester, has been on duty in Pensacola Township, Yancey County, in which most of the park is situated. This man has assisted, by patrol and educational work, in keeping down fires on the lower slopes of the mountain. The lumber company operating on the west side of the park and below it has been appealed to from time to time to do everything possible to prevent fires on their operations and they have shown a disposition to do what they can along these lines. They have agreed to maintain hoods or spark arresters on their locomotives, and to use all men available for extinguishing fires whenever they get well started. It is expected that all timber owned by this company will soon be cut and their operations will cease. Undoubtedly the danger to the park from fire will be greatly reduced when this happens.

This act provides no special fund for protecting or administering the park but opens a way whereby funds for this purpose may be secured. It is expected that the State Geological Board will shortly approve some preliminary measures, which it is hoped may eventually result in securing sufficient funds for the proper protection and administration of the park. For the first year or two, however, the results will undoubtedly be small and the Survey's own appropriation will have to be drawn upon to meet the necessary protection expenses. The same policy will be continued that has been in effect heretofore, and every effort will be made to protect the live standing timber which is now the great beauty and attraction of the park.

APPENDIX

VOLUNTARY TOWNSHIP FOREST FIRE CORRESPONDENTS IN NORTH CAROLINA REPORTING FOR 1920

MOUNTAIN REGION

ALLEGHANY

Township	*Name*	*Address*
Cherry Lane	J. T. Miles	Cherry Lane
	G. W. Miles	Miles
	O. O. Smith	Doughton
Cranberry	J. M. Blevins	Gray
	J. J. Miller	Laurel Springs
Gap Civil		
Glade Creek	A. O. Carico	Edmonds
Piney Creek	C. L. Hash	Piney Creek
Prathers Creek		
Whitehead	Wiley Combs	Whitehead

ASHE

Township	*Name*	*Address*
Chestnut Hill	J. E. Gambill	Crumpler
	J. F. Oliver	Crumpler
Clifton	J. C. Roland	Clifton
Creston	J. R. McMillan	Creston
Helton	Charles F. Sexton	Grassy Creek
Horse Creek	W. E. Perry	Grayson
	M. Neech	Edison
	C. C. Barker	Park, Va., R. F. D.
	Adolphus Shepherd	Edison
Jefferson		
Laurel		
North Fork		
Obids	D. H. Burgess	Obids
Old Fields	E. E. Trivett	Beaver Creek
Peak Creek	G. B. Austin	Laurel Springs
	W. L. Miller	Laurel Springs
	W. N. G. Wellborn	Laurel Springs
Piney Creek	H. M. Ashley	Lansing
	Jonathan Perry	Husk
Pine Swamp	V. L. Moretz	Hopkins
Walnut Hill		

AVERY

Township	*Name*	*Address*
Altamont	W. C. Franklin	Altamont
Banner Elk	T. L. Lowe	Banner Elk
Beech Mountain	F. C. Palmer	Heaton
	L. W. McGuire	Whaley
Cranberry		
Linville	J. L. Hartley	Linville
	E. C. Robbins	Pineola
Roaring Creek		
Toe River	J. P. Hall	Plumtree
Wilsons Creek	Monroe Coffey	Edgemont

BUNCOMBE

Township	*Name*	*Address*
Asheville		
Averys Creek		
Beaverdam		
Biltmore	J. M. Wagoner	Biltmore
Black Mountain	W. H. Burnett	Black Mountain
Fairview		
Flat Creek	H. C. Blackstock	Stocksville
French Broad	W. H. Hunter	Alexander
Haw Creek		
Hazel		
Ivy	M. T. Arrowood	Democrat
	J. H. Woodward	Democrat
Leicester		
Limestone		
Lower Hominy		
Reems Creek	W. C. Sprinkle	Weaverville
	J. C. Roberts	Weaverville
Sandy Mush	W. E. Waldrop	Sandy Mush
	A. L. Ingle	Odessa
Swannanoa		
Upper Hominy	J. S. Smith	Candler
	J. C. Waters	Candler
	J. C. Curtis	Candler, R. 3
	J. C. Byrd	Candler

BURKE

Township	*Name*	*Address*
Icard	G. L. Stine	Hildebran
Jonas Ridge		
Linville		
Lovelady	L. P. Guigou	Valdese
	L. L. Lowman	Connelly Springs
	D. W. Lowman	Connelly Springs
Lower Creek	J. V. Powell	Morganton
	W. P. Corpening	Worry
Lower Fork		
Morganton, No. 1		
Morganton, No. 2		
Quaker Meadow		
Silver Creek	J. A. Wainwright	Morganton, R. 1
	A. H. Conley	Morganton, R. 1
	S. C. Bennett	Bridgewater
Smoky Creek		
Upper Creek	M. S. Arney	Worry
Upper Fork		

CALDWELL

Township	*Name*	*Address*
Globe	J. B. Moore	Globe
	James Moore	Globe
	D. O. Moore	Globe
Hudson		
Johns River	W. T. Mays	Lenoir, R. F. D.
Kings Creek	G. M. Icenhour	Kings Creek
	Pickens Barlow	Kings Creek
Lenoir	J. L. Suddreth	Lenoir
	A. K. Joy	Lenoir
	G. A. Tuttle	Lenoir, R. 5
	W. O. Moore	Lenoir
	R. R. Corpening	Lenoir, R. 5
Little River	T. E. Story	Lenoir
Lovelady	Harvey Abernethy	Granite Falls
	G. W. Sherrill	Granite Falls
Lower Creek		
Mulberry	J. C. Coffey	Lenoir, R. 4
North Catawba		
Patterson	C. J. Dobbins	Finley
	John R. Hagaman	Patterson
	T. S. Setser	Patterson
Wilson Creek		
Yadkin Valley	R. L. Miller	Buffalo Cove
	Hugh A. Dobben	Legerwood

CHEROKEE

Beaverdam		
Hothouse	T. T. Johnson	Culberson, R. 2
Murphy	J. T. Hayes	Tomotla
Notla	A. H. Davidson	Letitia
Shoal Creek	G. M. Jones	Postell
Valleytown	S. H. Parker	Marble
	R. A. Dewar	Andrews

CLAY

Brasstown	T. B. Hampton	Brasstown
Hayesville	Ernest D. Penland	Hayesville
	T. C. Moore	Hayesville
	W. T. Bumgarner	Hayesville
	S. J. Bristol	Hayesville
Hiwassee		
Shooting Creek	N. N. Rogers	Shooting Creek
Tusquittee	Ed. T. Shearer	Hayesville
	J. V. A. Moore	Hayesville

GRAHAM

Cheoah		
Stecoah	M. A. Crisp	Stecoah
	J. B. Andrews	Japan
Yellow Creek	J. L. Green	Fontana

HAYWOOD

Beaverdam	B. W. Hall	Canton
Cataloochee	W. M. Sutton	Cataloochee
Cecil		
Clyde		
Crabtree	Albert McCracken	Clyde, R. 1
	J. L. Walker	Clyde
	C. E. Williams	Crabtree
East Fork	B. F. Sellers	Cruso

HAYWOOD—Continued

Township	*Name*	*Address*
Fines Creek	George A. Brown	Crabtree
Iron Duff		
Ivy Hill		
Jonathans Creek	Robert Howell	Waynesville
	E. J. Howell	Waynesville
Pigeon	Wm. Ledbetter	Canton, R. 2
	W. W. Wilson	Canton, R. 2
	H. P. Ledbetter	Canton, R. 2
Waynesville	W. M. Tate	Waynesville
White Oak		

HENDERSON

Blue Ridge	A. K. Hyder	Saconom
Clear Creek	R. M. Pryor	Hendersonville
	G. N. Sentell	Hendersonville, R.4
Crab Creek		
Edneyville	A. S. Edney	Hendersonville
	Lonnie R. Rhodes	Hendersonville
	C. Oates	Bear Wallow
Green River	W. F. Pace	Zirconia
	J. W. Ward	Zirconia
Hendersonville	George Gillespie	Horse Shoe
	A. Cannon	Horse Shoe
	G. H. Blankenship	Hillgirt
	C. S. Whitaker	Hendersonville, R.5
	John Eubanks	Hendersonville
Hooper Creek	J. V. Russell	Fletcher
	J. P. Fletcher	Fletcher
Mills River	George Gillespie	Horse Shoe
	J. W. Morgan	Hendersonville
	J. P. Whitaker	Horse Shoe
	J. H. Murray	Horse Shoe
	G. M. Brittain	Horse Shoe

JACKSON

Barkers Creek		
Canada	A. E. Galloway	Wolf Mountain
	W. T. Rigdon	Argura
Caney Fork	G. T. Nicholson	Cowarts
	W. H. Hooper	Cowarts
Cashiers Valley	C. G. Rogers	Cashiers
Cullowhee		
Dillsboro		
Greens Creek	J. C. Reed	Greens Creek
Hamburg	D. P. Moss	Glenville
	L. A. Wilson	Big Ridge
Mountain		
Qualla		
River	S. M. Parker	Tuckaseigee
Savannah		
Scott Creek	W. T. Derrick	Balsam
Sylva	R. W. Fisher	Sylva, R. 1
Webster		

MACON

Burningtown	Robert Ramsey	Tellico
Cartoogechaye		
Cowee	W. J. Jenkins	Wests Mill
	J. A. Lakey	Etna
Ellijay	Noah L. Jollay	Cullasaja

MACON—Continued

Township	*Name*	*Address*
Flatts	J. E. Vinson	Dillard, Ga.
Franklin	N. L. Barnard	Franklin
Highlands	J. B. Phillips	Shortoff
	T. G. Harbison	Highlands
Millshoal		
Nantahala	Jos. W. Gregory	Aquone
Smith Bridge		
Sugar Fork	J. M. Kenner	Scroll

MADISON

Township	*Name*	*Address*
No. 1		
No. 2		
No. 3	Thos. J. Murray	Marshall
No. 4	W. B. Holcomb	Waverly
No. 5	Dick Murray	Mars Hill, R. 2
No. 6		
No. 7	J. J. Ledford	Marshall, R. 5
	R. F. Payne	Marshall
No. 8	H. S. Davis	Spring Creek
	G. W. Sawyer	Bluff
No. 9	D. H. Gardner	Paint Rock
No. 10		
No. 11	E. E. Bryan	Faust
	W. M. English	Faust
No. 12	Jacob A. Marley	Marley
	W. B. Randall	Barnard
No. 13	W. A. Norris	Joe
	J. E. Gregory	Joe
	T. F. Stormy	Joe
No. 14		
No. 15	J. A. Ball	Mars Hill
	J. A. Ramsey	Mars Hill
No. 16		

McDOWELL

Township	*Name*	*Address*
Brackett		
Broad River	W. L. Nanney	Black Mountain
Crooked Creek	A. B. Burger	Old Fort
Dysartsville	R. F. Sisk	Nebo
	J. B. Kirksey	Dysartsville
Glenwood		
Higgins	L. A. Haney	Nealsville
Marion	W. L. Ferguson	Marion
	D. A. Snipes	Garden City
Montford Cove		
Nebo		
North Cove	J. B. Lonon	Ashford
Old Fort	J. H. Young	Old Fort

MITCHELL

Township	*Name*	*Address*
Bakersville	W. L. Lambert	Bakersville
	W. J. Slagle	Bakersville
	E. D. Bowditch	Toecane
Bradshaw		
Cane Creek	T. A. Buchanan	Hawk
Fork Mountain	D. M. Cook	Bakersville
Grassy Creek		
Harrell		
Little Rock		
Poplar	Billie Peterson	Poplar

MITCHELL—Continued

Township	*Name*	*Address*
Poplar	M. D. Peterson	Huntdale
	Ed. Barnett	Relief
Red Hill		
Snow Creek		

POLK

Township	*Name*	*Address*
Columbus		
Cooper Gap	W. W. Gibbs	Mill Spring
Greens Creek	J. W. McFarland	Rutherfordton, R. 1
	R. L. Camp	Rutherfordton, R. 2
	W. M. Barnett	Landrum, S. C., R. 1
Saluda	Thomas E. Pace	Fish Top
	Henry P. Corwith	Saluda
Tryon	James M. Butler	Tryon
	D. E. Conner	Tryon
White Oak	J. M. Lewis	Mill Spring

RUTHERFORD

Township	*Name*	*Address*
Camp Creek	H. Forney	Union Mills
Chimney Rock	M. A. Searcy	Mill Spring, R. 2
	F. L. Logan	Chimney Rock
	Paul F. Searcy	Uree, R. 1
Colfax		
Cool Spring	J. B. Dill	Forest City
	Ambrose Crotts	Forest City
Duncan Creek		
Gilkey	J. D. Fincannon	Union Mills, R. 3
Golden Valley	L. S. Rollins	Bostic, R. 4
Green Hill	R. Ledbetter	Uree
High Shoal	T. H. Ferree	Caroleen
Logan Store		
Morgan	E. C. Hains	Union Mills
	W. J. Hardin	Rutherfordton, R. 3
Rutherford		
Sulphur Springs		
Union	James M. Owens	Rutherfordton, R.F.D.

SURRY

Township	*Name*	*Address*
Bryan	B. J. Snow	State Road
	W. J. Nixon	Kapps Mill
Dobson	J. F. Nance	Dobson
Eldorado		
Elkin	C. W. Young	Elkin
Franklin	J. M. Todd	Low Gap
Long Hill	T. W. Bryant	Ararat
	F. A. Ashburn	Mount Airy, R. 1
Marsh	H. E. Beamer	Rusk
Mount Airy		
Pilot	D. J. Denny	Pinnacle, R. 3
Rockford	J. W. Harbour	Rockford
	J. G. Burrus	Rockford
Shoals	M. F. Butner	Pinnacle
	C. W. Key	Pinnacle
Siloam		
Stewarts Creek	I. W. Reece	Mount Airy, R. 3
Westfield	H. E. Taylor	Pilot Mountain
	D. H. Jessup	Brim
	T. L. Brim	Brim
	W. W. W. Amburn	Mount Airy, R. 1

SWAIN

Township	Name	Address
Charleston	D. DeHart	Bryson City
Forneys Creek	G. I. Calhoun	Proctor
	Allen Welch	Proctor
Nantahala	E. H. Potter	Nantahala
	W. H. Baker	Judson
Ocona Lufty		

TRANSYLVANIA

Township	Name	Address
Boyd	James M. Case	Brevard, R. 2
Brevard		
Catheys Creek	J. M. Hamlin	Brevard
	F. Poxton	Cherryfield
	H. C. Fenwick	Selica
Dunns Rock		
Eastatoe	E. M. Whitmire	Rosman
Gloucester	Jesse M. McCall	Balsam Grove
Hogback	T. C. McCall	Quebec
Little River	J. C. Capps	Pisgah Forest
	A. J. Beddingfield	Penrose

WATAUGA

Township	Name	Address
Bald Mountain		
Beaverdam	Smith Hagaman	Vilas
	S. C. Eggers	Vilas
Blowing Rock	R. K. Hartley	Blowing Rock
Blue Ridge	W. D. Cook	Blowing Rock, R. 1
Boone	William L. Trivett	Boone
Cove Creek	N. L. Mast	Mast
Elk	T. L. Critcher	Bamboo
	J. W. Hayes	Bamboo
Laurel Creek	D. Charles Mast	Sugar Grove
Meat Camp	W. W. Norris	Sands
	C. G. Hodges	Sands
	F. C. Hodges	Sands
North Fork	J. M. May	Trade, Tenn., R. 2
	J. O. J. Potter	Tamarack
	F. M. Thomas	Trade, Tenn.
Shawneehaw		
Stony Fork		
Watauga	G. W. Robbins	Shulls Mills
	J. F. Gregg	Shulls Mills

WILKES

Township	Name	Address
Antioch	L. M. Jarvis	Roaring River
Beaver Creek	Vance McGhinnis	Boomer
Boomer	T. C. McGhinnis	Boomer
	J. E. Phillips	Boomer
Brushy Mountain	J. J. Hendren	Pores Knob
	A. C. Parker	Gilreath
	A. N. Vannoy	Pores Knob

WILKES—Continued

Township	Name	Address
Edwards	M. F. Barker	Benham
	E. W. Settle	Benham
Elk	S. S. Barlow	Ferguson
	G. W. Welch	Mount Zion
Jobs Cabin	J. W. Church	Summit
Lewis Fork	E. C. Foster	Purlear
	F. F. Wolf	Purlear
	U. G. Foster	Champion
Lovelace	R. V. Wright	Hunting Creek
	Parks M. Reid	Spurgeon
	C. C. Wright	Hunting Creek
Moravian Falls	W. G. Meadows	Pores Knob
Mulberry	H. H. Jennings	North Wilkesboro
New Castle	G. W. Sale	Ronda
	C. M. Welborn	New Castle
North Wilkesboro		
Reddies River		
Rock Creek	T. J. McNeill	Roaring River
	W. N. Alexander	N. Wilkesboro, R. 2
Somers	S. A. Mitchell	New Castle
Stanton		
Trap Hill	G. W. Brown	Trap Hill
Union	David Roten	Sherman
	J. L. Whittington	Reddies River
Walnut Grove	W. L. Brewer	Brewers
	George E. Blevins	Springfield
Wilkesboro	W. D. Wood	Wilkesboro
	J. E. Winkler	Wilkesboro, R. 2
	A. G. Hendren	Straw
	H. H. Morehouse	Oakwoods

YANCEY

Township	Name	Address
Brush Creek	G. Penley Deyton	Green Mountain
	A. O. Greene	Green Mountain
Burnsville		
Cane River	W. S. Edwards	Cane River
	Gus F. Hensley	Bald Creek
	R. A. Radford	Cane River
Crabtree		
Egypt	D. M. Buck	Bald Mountain
Green Mountain	D. C. Renfro	Green Mountain
	J. M. Howell	Green Mountain
	S. H. Bryant	Dale
Jacks Creek	W. D. Peterson	Day Book
	Carl T. Young	Day Book
	A. V. Honeycutt	Burnsville
Pensacola	R. R. Ray	Pensacola
Price Creek	Joe Robison	Paint Gap
Ramseytown	J. A. Hannum	Ramseytown
South Toe	Aaron Shuford	Celo
	E. N. Harrison	Celo
	Arthur Patton	Harvard

PIEDMONT REGION

ALAMANCE

Township	Name	Address
Albright		
Boone Station		
Coble	W. L. Cates	Burlington
	G. A. Nicholson	Burlington, R. 1
	J. F. Homewood	Burlington

ALAMANCE—Continued

Township	Name	Address
Faucett	J. H. Tapscott	Union Ridge
Graham	Lewis H. Holt	Graham
	R. N. Cook	Graham
	H. J. Stockard	Graham
Haw River	J. H. Blackman	Haw River

ALAMANCE—Continued

Township	Name	Address
Melville	J. T. Shaw	Mebane
Morton	J. T. Bowles	Altamahaw, R. 2
Newlin	R. T. Moore	Saxapahaw
North Burlington		
Patterson	R. Z. Hornaday	Rock Creek
	R. G. Thompson	Rock Creek, R. 2
Pleasant Grove	W. B. Sellers	Mebane, R. 3
South Burlington		
Thompson	W. M. Overman	Graham, R. 2
	H. G. Paris	Graham, R. 2

ALEXANDER

Township	Name	Address
Ellendale		
Gwaltneys		
Little River	W. J. Bumgarner	Taylorsville
Miller	J. T. Hedrick	Stony Point, R. 3
Sharpes	Thos. F. Murdock	Hiddenite
	A. A. Somers	Stony Point
Sugar Loaf	J. Partee Russell	Taylorsville
Taylorsville		
Wittenburg		

ANSON

Township	Name	Address
Ansonville	B. D. Nelme	Wadesboro
Burnsville		
Gulledge		
Lanesboro		
Lilesville		
Morven		
Wadesboro		
White Store	J. T. Leonard	Peachland, R. 3

CABARRUS

Township	Name	Address
No. 1		
No. 2		
No. 3	C. H. Hamilton	Davidson
No. 4	E. E. Lady	Kannapolis
No. 5	L. J. Sapp	Concord
No. 6	John A. Suther	Concord, R. 4
No. 7	C. L. Earnhardt	Gold Hill, R. 3
	J. W. Honeycutt	Gold Hill, R. 3
No. 8	L. A. Lipe	Mount Pleasant
	H. E. Foil	Mount Pleasant
No. 9	D. M. Coley	Georgeville
	George C. Shinn	Georgeville
No. 10	H. T. Baker	Norwood
	John S. Turner	Stanfield
No. 11		
No. 12		

CASWELL

Township	Name	Address
Anderson		
Dan River	D. G. Watkins	Blanch
Hightowers	W. R. Morgan	Prospect Hill
Leasburg	Geo. B. Connally	Leasburg
Locust Hill	J. B. Worsham	McIver, R. F. D.
Milton	J. B. Yarbrough	Semora
Pelham		
Stony Creek		
Yanceyville	J. W. Wiggins	Yanceyville
	W. N. Harrelson	Yanceyville

CATAWBA

Township	Name	Address
Bandy		
Caldwell	T. L. Bandy	Catawba
Catawba	P. L. Smyre	Claremont
Clines	W. A. Hoke	Claremont
	J. H. C. Huitt	Catawba, R. 1
	G. W. Winebarger	Conover
Hickory	W. P. Bowman	Hickory
Jacobs Fork		
Mountain Creek		
Newton	J. Y. Killian	Newton

CHATHAM

Township	Name	Address
Albright	W. J. Thompson	Siler City, R. 1, Box 54
Baldwin	C. A. Snipes	Bynum
Bear Creek	Alex. B. Phillips	Bennett
Cape Fear		
Center	James L. Griffin	Pittsboro
Gulf	Grover C. Phillips	Bear Creek
Hadley		
Haw River		
Hickory Mountain		
Matthews		
New Hope		
Oakland		
Williams	J. E. Williams	Chapel Hill, R. 1

CLEVELAND

Township	Name	Address
No. 1	E. B. Hamrick	Boiling Springs
	R. B. McBee	Gaffney, S. C., R. 9
No. 2		
No. 3		
No. 4	H. W. Gallinure	Kings Mountain
No. 5	C. C. Bram	Waco
	S. L. Dellinger	Shelby, R. 1
	T. L. Hord	Waco
	J. F. Roberts	Shelby
No. 6		
No. 7	M. M. Greene	Mooresboro
	J. B. Lattimore	Lattimore
	W. W. Washburn	Shelby, R. 4
No. 8		
No. 9		
No. 10	J. M. Carpenter	Belwood
	J. R. Hoyle	Belwood, R. 1
	Dr. Joseph Willis	Belwood, R. 1, Box 19
No. 11		

DAVIDSON

Township	Name	Address
Abbotts Creek		
Alleghany	F. M. Cook	Handy
	A. H. Michael	Chandler
	C. W. Stokes	Newsom
Arcadia	Isaac P. Fischel	Clemmons, R. 2
Boone		
Conrad Hill		
Cotton Grove		
Emmons		
Hampton	W. L. Davis	Clemmons
Healing Springs	J. A. Kinney	High Rock
Jackson Hill		

DAVIDSON—Continued

Township	Name	Address
Lemelys		
Lexington		
Midway	James Nifong	Winston-Salem, R.4
Reedy Creek	John S. Hege	Clemmons, R. 2
Silver Hill	C. A. Hedrick	Lexington, R. 6
Thomasville	J. W. Bowers	Thomasville
Tyro	Joe Sink	Lexington, R. 5, Box 25
	F. F. Snyder	Linwood
Yadkin College	Edw. L. Greene	Yadkin College
	M. F. Phillips	Yadkin College

DAVIE

Township	Name	Address
Calahaln	A. D. Ratledge	Calahaln
Clarksville	D. R. Eaton	Cana
Farmington	M. J. Hendricks	Cana
Fulton	G. T. Tucker	Advance
Jerusalem	J. D. Goins	Cooleemee
Mocksville	James H. Cain	Mocksville
Shady Grove		

DURHAM

Township	Name	Address
Carr		
Cedar Fork		
Durham	J. W. Ferrell	Durham, R. 2, Box 129
Lebanon	J. E. Cole	Durham, R. 2
	J. N. W. Latta	Durham, R. 2
Mangum	W. J. Young	Rougemont
Oak Grove		
Patterson	P. H. Massey	Durham, R. 3

FORSYTH

Township	Name	Address
Abbotts Creek	E. L. Carter	Kernersville
Belews Creek		
Bethania		
Broad Bay	W. R. Rominger	107 Flat Rock St., Winston-Salem
	C. N. Reed	Winston-Salem, R.5
Clemmonsville		
Kernersville	D. W. Harmon	Kernersville
Lewisville		
Old Richmond	J. D. Anderson	Tobaccoville
	O. V. Pfaff	Tobaccoville
	J. R. Wall	Tobaccoville, R. 3, Box 14
Old Town		
Salem Chapel	J. A. Marshall	Walnut Cove
South Fork	J. M. Jarvis	Winston-Salem, R.1
Vienna	C. F. Micker	Pfafftown
West Salem		
Winston	J. C. Bessart	Winston-Salem
	R. W. Pou	Winston-Salem

FRANKLIN

Township	Name	Address
Cedar Rock	T. W. Stokes	Louisburg
Cypress Creek		
Dunn		
Franklinton		
Gold Mine		
Harris	N. B. Young	Louisburg, R. 1
Hayesville	K. C. Hawkins	Kittrell, R. F. D.
Louisburg		
Sandy Creek	G. C. Parrish	Gupton
Youngsville		

GASTON

Township	Name	Address
Cherryville	L. H. J. Houser	Cherryville
	Jacob Kiser	Bessemer City
Crowders Mtn.	John J. Ormand	Bessemer City
Dallas	O. F. Carpenter	Worth
	J. A. Friday	Dallas, R. 1
	D. A. Medlin	High Shoals
Gastonia		
River Bend	W. B. Rutledge	Mount Holly
South Point	J. R. Henderson	Lowell

GRANVILLE

Township	Name	Address
Brassfield		
Dutchville	J. H. Perry	Creedmoor
Fishing Creek	E. C. Harris	Oxford
Oak Hill	D. T. Winston	Virgilina, Va., R. 2
Oxford	B. S. Royster	Oxford
Salem		
Sassafras Fork	C. C. Heggie	Stovall
Tally Ho	W. S. Gooch	Stem
Walnut Grove	L. B. McFarland	Berea, R. 1
	B. T. Dean	Oxford, R. 4

GUILFORD

Township	Name	Address
Bruce		
Center Grove	L. A. Walker	Summerfield
Clay	G. A. Garrett	
Deep River		
Fentress	J. B. Watlington	Pleasant Garden
Friendship	S. A. Kirkman	Guilford College, R. 1
Gilmer		
Greene	L. W. Causey	Liberty
High Point		
Jamestown		
Jefferson	E. S. Holt	McLeansville
Madison		
Monroe		
Morehead		
Oak Ridge		
Rock Creek	W. R. Wood	Gibsonville
Sumner	R. C. Short	Greensboro, R. 1
	A. O. Newman	Greensboro, R. 1

IREDELL

Township	Name	Address
Barringer		
Bethany		
Chambersburg		
Coddle Creek		
Concord		
Cool Spring	V. C. Montgomery	Statesville, R. 7
Davidson		
Eagle Mills	G. W. Baity	Harmony
	T. L. Barnard	Houstonville
	A. F. Cook	Harmony, R. 3
	P. B. Kennedy	Houstonville
	Marvin W. Smith	Harmony
Fallistown		
New Hope	J. L. Reid	New Hope
Olin		
Sharpsburg	W. B. McLelland	Stony Point
Shiloh		
Statesville	E. S. Millsaps	Statesville
Turnersburg	J. N. Barron	Harmony
	Robert F. Gaither	Harmony

LEE

Township	Name	Address
Cape Fear	J. F. Jonas	Broadway
	L. L. Thomas	Jonesboro
Deep River		
East Sanford		
Greenwood	J. J. Edwards	Lemon Springs
Jonesboro		
Pocket	J. W. Knott	Sanford, R. 1
West Sanford		

LINCOLN

Township	Name	Address
Catawba Springs	J. G. Morrison	Stanley
Howards Creek	W. C. Kiser	Reepsville
	H. K. Sullivan	Lincolnton
Ironton	G. B. Goodson	Lincolnton, R. 3
	George M. Michael	Iron Station
	J. E. Reinhardt	Iron Station
Lincolnton		
North Brook	C. L. Eaker	Cherryville, R. 1
	T. Pate Jenks	Henry, R. 3

MECKLENBURG

Township	Name	Address
Berryhill		
Charlotte	J. A. Baldwin	Charlotte
	J. Y. Orders	Charlotte, R. 2
Clear Creek		
Crab Orchard		
Deweese	Walter P. Sloan	Davidson
Huntersville	M. W. Van Pelt	Huntersville
Lemleys	James F. Blythe	Huntersville, R. 22
	J. A. Boyles	Davidson, R. 25
Long Creek		
Mallard Creek	H. Y. Galloway	Derita, R. 14
	A. F. Long	Charlotte, R. 8
Morning Star		
Paw Creek		
Pineville		
Providence		
Sharon	A. B. Hood	Matthews, R. 27
Steele Creek	C. R. Choate	Charlotte, R. 3
	J. L. Millwee	Pineville, R. 15

MONTGOMERY

Township	Name	Address
Biscoe	N. C. McLeod	Biscoe
	J. M. Wright	Biscoe
Cheeks Creek	C. E. Brookshire	Mount Gilead, R. 3
	D. J. Poole	Pekin
Eldorado	J. A. Kirk	Eldorado
	N. M. Thayer	Eldorado
Hill	Carl McGill	Steeds
Hollingsworth	E. R. Sheffield	Candor
Little River	W. A. Leach	Martins Mill
Mount Gilead	R. M. Bruton	Wadeville
	J. B. Hurley, Sr.	Mount Gilead
	H. T. Scarborough	Mount Gilead
	J. A. Lisk	Mount Gilead
Ophir	N. S. Hamilton	Immer
Pee Dee		
Rocky Springs	M. A. Bennett	Jackson Springs
Troy		

MOORE

Township	Name	Address
Ben Salem	John A. Copeland	Eagle Springs
	M. A. Monroe	Eagle Springs
Carthage		
Deep River		
Greenwood	M. D. McLean	Cameron
	H. P. McPherson	Cameron
McNeills		
Mineral Springs	Pinehurst General Office	Pinehurst
Ritters	J. T. Seawell	Putnam
Sandhills		
Sheffields		

ORANGE

Township	Name	Address
Bingham	Thos. J. Oldham	Mebane, R. 2
Cedar Grove		
Chapel Hill	M. Lindsay	Chapel Hill
	J. M. Lloyd	Hillsboro, R. 3
Cheeks	James O. Webb	Efland
Eno	Robert M. Hill	Hillsboro
Hillsboro		
Little River		

PERSON

Township	Name	Address
Allenville		
Bushy Fork	R. S. Bayner	Hurdle Mills, R. 2
Cunningham		
Flat River	James C. Cates	Timberlake
Holloway	J. B. Barnett	Woodsdale
	G. E. Woody	Woodsdale
Mount Tirzah		
Olive Hill	T. C. Wagstaff	Roxboro
	W. A. Winstead	Roxboro
Roxboro		
Woodsdale		

RANDOLPH

Township	Name	Address
Asheboro	J. S. Ridge	Asheboro
Back Creek	N. H. Ferguson	Randleman
	J. T. Redding	Randleman, R. 3
Brower	W. M. Moffitt	Moffitt
	M. F. Wrenn	Steeds, R. 1
Cedar Grove		
Coleridge	H. T. Bray	Ramseur
	Enterprise Mfg. Co.	Coleridge
	H. P. Moffitt	Ramseur
	W. C. Stout	Ramseur
Columbia	John T. Turner	Ramseur
	J. A. Ward	Ramseur
	E. C. Watkins	Ramseur
Concord	M. N. Morgan	Farmer
	J. M. Yates	Mechanic
Franklinville	J. T. Winslow	Asheboro
Grant	S. S. Cox	Asheboro, Star Rt.
	C. O. Ingold	Asheboro, R. 1
Level Cross		
Liberty	W. B. Owen, Sr.	Liberty
New Hope	G. E. Carter	Eleazer
	J. T. Thornbury	Rachel

RANDOLPH—Continued

Township	Name	Address
New Market	J. A. Wall	Sophia
Pleasant Grove	J. T. Powers	Bear Creek, R. 3
Providence		
Randleman	A. N. Bulla	Randleman
	N. T. Groce	Worthville
Richland	C. E. Stuart	Seagrove
Tabernacle		
Trinity		
Union	S. A. Cox	Pisgah

ROCKINGHAM

Township	Name	Address
Huntsville		
Leaksville	J. M. Price	Leaksville
	L. J. Shelton	Spray
Madison	V. H. Idol	Madison
Mayo	T. B. Lindsay	Stoneville
	T. L. Smith	Stoneville
	R. T. Stone	Stoneville
New Bethel	W. G. Sharpe	Wentworth
	P. H. Simpson	Summerfield, R. 1
Price		
Reidsville	John Bennett	Reidsville, R. 1
	Robert P. Mitchell	Reidsville
Ruffin	W. G. Dix	Ruffin
	M. Stokes	Ruffin
Simpsonville	W. K. Gibbs	Reidsville
	D. E. Purcell	Wentworth, R. 1
Wentworth	J. W. Moore	Reidsville
Williamsburg	George T. Davis	Reidsville
	W. S. McKinney	McIver

ROWAN

Township	Name	Address
Atwell	J. L. Fleming	China Grove
	F. D. Patterson	China Grove
China Grove	L. A. Carriber	Landis
	C. J. Deal	Landis
	G. H. Lipe	China Grove
Cleveland	E. B. Davis	Cleveland
	A. L. Powlas	Barber
	D. B. Rosebrough	Cleveland
Franklin		
Gold Hill		
Litaker		
Lock		
Morgan	C. A. Campbell	Gold Hill
Mount Ulla		
Providence		
Salisbury	A. L. Smoot	Salisbury
Scotch-Irish	Jonathan Lyerly	Woodleaf, R. 1
Steel		
Unity		

STANLY

Township	Name	Address
Almond	R. H. Burleyson	Albemarle
	U. S. Burleyson	Albemarle, R. 6
Big Lick	D. E. Efird	Albemarle
Center		
Endy	L. H. Bost	Albemarle, R. 6

STANLY—Continued

Township	Name	Address
Endy	D. P. McSwain	Albemarle
Furr		
Harris		
North Albemarle		
Ridenhour	R. L. Lipe	Richfield, R. 1
South Albemarle	J. C. Parker	Albemarle
Tyson	J. M. Reap	Albemarle, R. 5

STOKES

Township	Name	Address
Beaver Island		
Big Creek	Joe Francis	Francisco
Danbury		
Meadow	I. G. Ross	Walnut Cove
Peters Creek		
Quaker Gap		
Sauratown		
Snow Creek		
Yadkin	D. V. Carroll	Mizpah
	J. H. Covington	Mizpah

UNION

Township	Name	Address
Buford	J. C. Long	Monroe
Goose Creek	W. G. Long	Unionville
	A. W. McManus	Unionville, R. 1
Jackson		
Lanes Creek	B. F. Parker	Monroe
Marshville	T. C. Griffin	Marshville
Monroe	M. L. Flow	Monroe
New Salem	M. C. Austin	Marshville, R.F.D.
Sandy Ridge		
Vance	P. C. Stinson	Monroe

VANCE

Township	Name	Address
Dabney		
Henderson		
Kittrell	J. P. Allen	Henderson
Middleburg	Alfred Plummer	Middleburg
	B. S. Porham	Henderson, R. 3
Nutbush	C. M. White	Manson
Sandy Creek	E. T. Alston	Henderson
Townsville	J. E. Kimball	Clarksville, Va., R.F.D.
Watkins		
Williamsboro	R. A. Bullock	Henderson, R. 3
	J. H. Rice	Henderson, R. 7

WAKE

Township	Name	Address
Bartons Creek		
Buckhorn		
Cary		
Cedar Fork	E. M. Ellis	Morrisville
	J. T. Horton	Morrisville
Holly Springs		
House Creek	Sion H. Smith	Cary, R. 1, Box 59
Leesville	M. J. Carlton	Raleigh, R. 6
	A. G. Ray	Raleigh, R. 7
Little River		
Marks Creek		
Middle Creek		

WAKE—Continued

Township	*Name*	*Address*
Neuse River	J. D. Willson	Neuse
	J. B. Wiggins	Neuse, R. 1
New Light	W. D. Sandling	Wake Forest, R. 4
Panther Branch	Miss S. M. Adams	Willow Springs
Raleigh		
St. Marys	Troy Pool	Auburn
St. Matthews		
Swift Creek		
Wake Forest	F. J. Duke	Wake Forest
White Oak	W. T. Hunt	Apex

WARREN

Fishing Creek	J. F. Hunter	Arcola
Fork	W. H. Pridgen	Creek
Hawtree		
Judkins		
Nutbush	A. E. Paschall	Manson
	R. D. Paschall	Ridgeway
River		
Roanoke	H. L. Wall	Littleton, R. 3
Sandy Creek	S. J. Pritchard	Henderson, R. 6
Shocco		
Six-pound	C. F. Burrow	Macon, R. 3

WARREN—Continued

Township	*Name*	*Address*
Smith Creek	J. F. P. Horton	Norlina
Swan Quarter	George Robinson	Ridgeway
	G. E. White	Norlina

YADKIN

Boonville	M. M. Crumel	Boonville
	A. S. Speer	Boonville
Buck Shoal	E. G. Myers	Hamptonville
	G. T. White	Hamptonville
Deep Creek	S. T. Hinshaw	Yadkinville
	J. W. McCoy	Yadkinville
East Bend	J. G. Hoff	East Bend
	J. T. Watt	East Bend
	W. P. Williams	East Bend
Fall Creek	C. A. Hall	Siloam, R. 2
	J. R. Hall	Siloam
	E. B. Vestal	Siloam
	E. J. Vestal	Yadkinville
Forbush	John H. Eaton	Yadkinville
	J. K. Gough	East Bend
Knobs	J. G. Groce	Jonesville
Liberty	J. C. Money	Yadkinville
Little Yadkin		

COASTAL PLAIN REGION

BEAUFORT

Bath	W. M. Kear	Washington
	G. H. Elliott	Washington
Chocowinity		
Long Acre		
Pantego		
Richland	J. A. Hardy	Aurora
Washington		

BERTIE

Colerain	D. R. Britten	Colerain
Indian Woods	E. D. Spruill	Quitsna
Merry Hill	T. A. Smithwich	Merry Hill
Mitchell	A. E. Gawlt	Aulander
Roxobel	George T. Parker	Kelford
Snake Bite	J. Rufus Cherry	Windsor
Whites		
Windsor		
Woodville		

BLADEN

Abbotts		
Bethel	H. J. Lyon	Elizabethtown
Bladenboro	S. N. Ferguson	Bladenboro
Brown Marsh		
Carvers Creek	J. K. Nicholson	Council
Central	R. P. Tatum	Ruskin
Colly		
Cypress Creek		
Elizabethtown		
Frenchs Creek		
Hollow	C. H. Brisson	St. Pauls, R. 4
Lake Creek	D. J. Sessoms	Ivanhoe
Turnbull		

BLADEN—Continued

White Oak		
Whites Creek	I. A. Register	Council
	D. J. Priest	Council, R. 2
	G. D. Perry	Council

BRUNSWICK

Lockwoods	J. J. Hewett	Supply
Northwest		
Shallotte		
Smithville		
Town Creek		
Waccamaw		

CAMDEN

Courthouse	T. B. Godfrey	Camden
	Mrs. B. B. Sawyer	Belcross
Shiloh		
South Mills		

CARTERET

Beaufort		
Carteret		
Cedar Island		
Harkers Island	W. H. Guthrie	Harkers Island
Harlowe		
Hunting Quarters		
Merrimon		
Morehead		
Newport	A. L. Wilson	Newport
Portsmouth		
Straits		
Smyrna	Henry O. Piner	Williston
White Oak		

CHOWAN

Township	Name	Address
No. 1		
No. 2	M. B. Chappel	Edenton
	I. J. Moran	Edenton
No. 3	W. C. Ward	Ryland
	E. C. Welch	Tyner
No. 4		

COLUMBUS

Township	Name	Address
Bogue	J. E. Thompson	Hallsboro
	J. B. Wyche	Hallsboro
Bolton	M. D. Creech	Bolton
Bug Hill	J. H. Lay	Pireway
	W. A. Marlow	Dothan
	Major Smith	Bug Hill
Chadbourn	G. H. Thompson	Chadbourn, R. 1
Fair Bluff		
Lees	Hosea Simmons	Vineland
	N. M. Ward	Nakina
Ransom	S. M. Newell	Bolton
	W. L. Hobbs	Delco
South Williams	W. C. Gore	Clarendon
Tatoms		
Waccamaw		
Welch Creek		
Whiteville	B. White	Vineland

CRAVEN

Township	Name	Address
No. 1		
No. 2		
No. 3	J. R. Jolley	Fort Barnwell
	J. S. Robinson	Cove City
No. 4		
No. 5	James L. Taylor	Bachelor
	John S. Morton	North Harlowe
No. 6		
No. 7	W. E. Moore	New Bern, R. 5
No. 8	Pine Lumber Co.	New Bern
No. 9		

CUMBERLAND

Township	Name	Address
Beaver Dam	Fred. E. Bullard	Roseboro
Black River	Nathan Williams	Godwin
	D. B. Bain	Wade
Carvers Creek		
Cedar Creek		
Cross Creek	E. A. Poe	Fayetteville
Flea Hill	H. H. Bolton	Fayetteville
	D. D. Bain	Wade, R. 1
Grays		
Manchester		
Pearces Mill		
Rockfish	L. M. Culbreth	Cumberland
Seventy-first	S. M. Hobbs	Linden

CURRITUCK

Township	Name	Address
Crawford	W. J. Tate	Coinjock
	A. B. Midgett	Coinjock
Fruitville	David Jones	Knotts Island
Moyock	W. M. Stuart	Vine, Va.
Poplar Branch		

DARE

Township	Name	Address
Atlantic		
East Lake	Claude C. Duvall	Buffalo City
Hatteras	N. F. Jennett	Buxton
	B. B. Ballance	Hatteras
Kennekeet		
Nags Head	Theo. S. Meekins	Manteo
	M. G. Hollowell	Nags Head

DUPLIN

Township	Name	Address
Albertson	S. W. Peal	Seven Springs
Cypress Creek		
Faison	Z. V. Blount	Faison
Glisson		
Island Creek		
Kenansville	Henry Dail	Kenansville
Limestone		
Magnolia		
Rockfish		
Rose Hill		
Smith		
Warsaw		
Wolfscrape		

EDGECOMBE

Township	Name	Address
No. 1	Mrs. J. C. Powell	Tarboro
	F. H. Pender	Tarboro
No. 2		
No. 3		
No. 4		
No. 5	C. H. Spivey	Tarboro, R. 4
No. 6		
No. 7	S. N. Weeks	Battleboro
No. 8	W. W. Eagles	Macclesfield
No. 9	C. W. Owens	Fountain
	D. R. Mercer	Fountain
	H. C. Turnage	Fountain
No. 10	E. L. Pitt	Pinetops
	Robert E. Pitt	Pinetops
No. 11	George D. Britt	Tarboro
No. 12		
No. 13		
No. 14		

GATES

Township	Name	Address
Gatesville		
Hall	E. H. Eure	Eure
Haslett		
Holly Grove		
Hunters Mill	B. H. Ward	Bosley
	J. M. Beaman	Sunbury
Mintonville	T. J. Carter	Hobbsville
Reynoldson	E. S. Ellenor	Gates

GREENE

Township	Name	Address
Bull Head	J. L. Eason	Stantonsburg
Carrs		
Hookerton	N. F. Palmer	Hookerton
Jason	W. D. Mewborn	LaGrange
Olds	T. E. Marrow	Farmville
Ormond		
Shine		
Speights Bridge		

HALIFAX

Township	*Name*	*Address*
Brinkleyville		
Butterwood	W. E. Nicholson	Airlie
Conocanary		
Enfield	S. B. Holloway	Enfield
Faucett		
Halifax		
Littleton	C. D. House	Thelma
Palmyra	R. H. White	Hobgood
Roanoke Rapids		
Roseneath		
Scotland Neck	J. E. Shields	Scotland Neck
Weldon		

HARNETT

Anderson Creek	J. S. Johnson	Spout Springs
Averasboro	J. W. Whitehead	Dunn
	V. L. Stephens	Dunn
Barbecue		
Black River		
Buckhorn	J. D. Champion	Fuquay Spgs., R. 1
	W. A. Avent	Kipling
Duke	H. V. Moulton	Duke
Grove	L. L. Levinson	Coats
Hectors Creek	A. L. Baughcom	Fuquay Springs
	H. S. Holloway	Cardenas
Johnsonville	D. P. McDonald	Olivia
	C. C. Cameron	Pineview
Lillington		
Neills Creek		
Stewarts Creek		
UpperLittleRiver	J. B. F. Stewart	Mamers

HERTFORD

Ahoskie		
Harrellsville		
Maneys Neck	S. P. Winborne	Como
Murfreesboro		
St. Johns	Clarence Chavis	Ahoskie
	J. J. Askew	Ahoskie
Winton	H. H. Jones	Winton

HOKE

Allendale		
Antioch		
Blue Springs		
Little River	J. H. Priest	Manley
McLauchlin		
Quewhiffle		
Raeford		
Stonewall	L. S. McInnis	Dundarrach

HYDE

Currituck	Geo. T. Radcliff	Leechville
	T. A. Griffin	Scranton
Fairfield		
Lake Landing	George E. Roper	Engelhard
	W. W. Watson	Lake Landing
	J. M. Hall	Middletown
Ocracoke		
Swan Quarter	I. R. Credle	Swan Quarter

HYDE—Continued

Township	*Name*	*Address*
Swan Quarter	F. Collin Barber	Lake Landing
	J. W. Jarvis	Swan Quarter

JOHNSTON

Banner	John W. Wood	Benson, R. 2
	A. L. Stephenson	Benson
	W. D. Boon	
Bentonsville	J. M. Beasley	Bentonville
Beulah	W. G. Pittman	Kenly
Boon Hill		
Clayton		
Cleveland		
Elevation		
Ingrams	J. W. Sanders	Four Oaks
	B. B. Adams	Four Oaks
Meadow	J. J. Rose	Bentonville
Micro		
O'Neals	P. B. Chamblee	Zebulon
	W. E. Parker	Middlesex, R. 3
Pine Level	H. R. Gerald	Pine Level
	N. G. Wiggs	Princeton
Pleasant Grove		
Selma		
Smithfield	William D. Avera	Smithfield
Wilders	J. I. Whitley	Wendell, R. 1
Wilson Mills		

JONES

Beaver Creek	H. L. Wooten	Kinston, R. 6
Chinquapin		
Cypress Creek	C. A. Rhodes	Comfort
Pollocksville	F. H. Foy	Pollocksville
Trenton	T. A. Windley	Trenton
Tuckahoe	D. W. Dudley	Comfort
White Oak		

LENOIR

Contentnea Neck	W. P. Gilbert	Grifton
	J. S. Abbott	Kinston
Falling Creek		
Institute		
Kinston		
Moseley Hall	Samuel T. Meares	LaGrange
Neuse		
Pink Hill		
Sand Hill		
Southwest		
Trent		
Vance		
Woodington		

MARTIN

Beargrass	McG. Taylor	Williamston
Cross Roads		
Goose Neck	J. W. Hines	Oak City
Griffins		
Hamilton		
Jamesville		
Poplar Point	Jesse A. Leggett	Williamston, R. 3
	James R. Everett	Williamston
Robersonville		
Williams	J. L. Coltrain	Williamston
Williamston		

NASH

Township	Name	Address
Bailey		
Castalia		
Coopers		
Dry Wells		
Ferrells	W. B. Bergeron	Middlesex
Griffins	Hollister Lbr. Co.	Hollister
	A. W. Cooper	Whitakers
Jackson		
Mannings		
Nashville		
North Whitakers		
Oak Level		
Red Oak		
Rocky Mount		
South Whitakers		
Stony Creek	J. W. Culpepper	Rocky Mount

NEW HANOVER

Cape Fear		
Federal Point		
Harnett		
Masonboro		
Wilmington		

NORTHAMPTON

Gaston		
Jackson	John E. Moore	Jackson
	J. S. Grant	Jackson
Kirby	W. T. Bridgers	Conway
Occoneechee		
Pleasant Hill	J. W. Magee	Pleasant Hill
	G. W. Massey	Pleasant Hill
Rich Square	A. J. Conner	Rich Square
Roanoke	D. T. Hicks	Lasker
Seaboard		
Wiccacanee	J. G. Bottoms	Margarettsville

ONSLOW

Jacksonville	Edw. J. Scott	Jacksonville
Richlands	J. W. Fountain	Richlands
Stump Sound	J. T. Shepard	Holly Ridge
Swansboro	D. J. Sanders	Hubert
White Oak	A. A. Eubank	

PAMLICO

No. 1		
No. 2	J. W. Martin	Florence
No. 3		
No. 4		
No. 5		

PASQUOTANK

Elizabeth City	T. B. Wilson	Elizabeth City
Mount Hermon	J. W. Perry	Okisko
Newland	W. J. Williams	Elizabeth City, R. 6
Nixonton	C. L. Ball	Elizabeth City, R. 1
	J. L. Brock	Elizabeth City, R. 2
Providence	W. S. Stafford	Elizabeth City, R. 3
	M. P. Jennings	Elizabeth City
Salem	J. C. James, Jr.	Weeksville

PENDER

Township	Name	Address
Burgaw	A. H. Paddison	Burgaw
Caintuck	E. A. Howes	Atkinson
	D. J. Corbett	Currie
Caswell		
Columbia	A. D. Ward	Currie
	George F. DeVane	Ivanhoe
Grady		
Holly	J. A. Dainer, Jr.	Maple Hill
Long Creek		
Rocky Point	W. W. Pearsall	Rocky Point
Topsail	J. Horner	Scotts Hill
	J. C. Nixon	Topsail
Union		

PERQUIMANS

Belvidere		
Bethel		
Hertford		
New Hope	Arthur Butt	Hertford
Parkville	T. C. Stony	Winfall

PITT

Ayden	J. R. Smith	Ayden
	J. R. Henry	Grifton
Beaver Dam		
Bethel	R. D. Whitehurst	Bethel
Belvoir		
Carolina		
Chicod	J. J. Elk	Grimesland
Falkland		
Farmville	John T. Thorne	Farmville
	J. R. Davis	Farmville
Fountain		
Greenville	J. J. Harrington	Greenville
Pactolus		
Swift Creek		
Winterville	J. J. May	Greenville
	A. G. Cox	Winterville

RICHMOND

Beaverdam	G. C. Baldwin	Hoffman
Black Jack	J. F. Capel	Ellerbe, R. 2
Marks Creek	W. H. H. Bagwell	Hamlet
	M. B. Nicholson	Osborne
Mineral Springs	J. R. Wall	Ellerbe
Rockingham	J. A. Hutchinson	Roberdel
Steeles	A. Baldwin	Ellerbe, R. 1
	A. J. Little	Mangum
Wolf Pit	W. H. Roberts	Rockingham

ROBESON

Alfordsville		
Back Swamp		
Britts		
Burnt Swamp		
Fairmont		
Gaddy		
Howellsville		
Lumber Bridge		
Lumberton		

ROBESON—Continued

Township	*Name*	*Address*
Marietta		
Maxton	Rory McNair	Maxton
Orrum	R. W. Nye	Orrum
	M. W. Hedgpeth	Orrum
Parkton		
Pembroke		
Raft Swamp	R. F. Gregory	Lumberton
	W. C. Townsend	Lumberton
	W. K. Culbreth	Lumberton
	L. E. Tyner	Buies
Red Springs	A. D. McLeod	Red Springs
	J. L. McMillan	Red Springs
Rennert	C. W. Watson	Rennert
Rowland	A. T. McKellor	Rowland
Saddletree	E. B. Paul	Lumberton
	John H. Powers	Lumberton, R.F.D.
St Pauls	J. F. Hamilton	St. Pauls
Shannon		
Smiths		
Sterlings		
Thompson	W. L. Price	McDonald
	Foster Williams	McDonald
Wishart		

SAMPSON

Township	*Name*	*Address*
Dismal		
Franklin	B. C. Triplett	Kerr
Halls	J. A. Fort	Clinton
Herrings		
Honeycutts		
Lisbon	J. D. Johnson	Garland
	C. A. Brown & Bro.	Garland
Little Coharie		
McDaniels		
Mingo		
Newton Grove		
North Clinton		
Piney Grove		
South Clinton		
Taylors Bridge		
Turkey		
Westbrooks	Westbrook Lee, Sr.	Newton Grove

SCOTLAND

Township	*Name*	*Address*
Laurel Hill	J. A. Jackson	Laurinburg
Spring Hill	Neill A. McKay	Wagram

SCOTLAND—Continued

Township	*Name*	*Address*
Stewartsville	S. W. Covington	Laurinburg
Williamson	H. D. Gibson	Gibson
	F. L. Rachels	Old Hundred

TYRRELL

Township	*Name*	*Address*
Alligator		
Columbia	E. B. Hopkins	Columbia
Gum Neck		
Scuppernong	E. R. Davenport	Columbia
South Fork		

WASHINGTON

Township	*Name*	*Address*
Lees Mill	N. C. Vail	Plymouth
	J. E. Singleton	Roper
Plymouth		
Scuppernong		
Skinnersville	C. L. Everett	Mackeys

WAYNE

Township	*Name*	*Address*
Brogden	W. N. Anderson	Dudley
	W. F. English	Mount Olive
Buck Swamp		
Fork	W. C. Hollowell	Goldsboro
	D. C. Pipkin	Goldsboro
Goldsboro		
Grantham		
Great Swamp	B. R. Edgerton	Kenly, R. 1
Indian Springs		
Nahunta	S. H. Aycock	Fremont
New Hope		
Pikeville	P. B. Scott	Pikeville
	K. D. Perkins	Pikeville
Saulston		
Stony Creek		

WILSON

Township	*Name*	*Address*
Black Creek		
Cross Roads		
Gardner	L. P. Woodard	Wilson
Old Fields		
Saratoga		
Spring Hill	J. W. Bailey	Kenly
Stantonsburg	H. E. Thompson	Stantonsburg
Taylor		
Toisnot		
Wilson	H. B. Lane	Wilson, R. 4

PUBLICATIONS

OF THE

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

BULLETINS

1. Iron Ores of North Carolina, by Henry B. C. Nitze, 1893. 8°, 239 pp., 20 pl., and map. *Out of print.*
2. Building and Ornamental Stones in North Carolina, by T. L. Watson and F. B. Laney in collaboration with George P. Merrill, 1906, 8°, 283 pp., 32 pl., 2 figs. *Postage 25 cents. Cloth-bound copy 50 cents extra.*
3. Gold Deposits in North Carolina, by Henry B. C. Nitze and George B. Hanna, 1896. 8°, 196 pp., 14 pl., and map. *Out of print.*
4. Road material and Road Construction in North Carolina, by J. A. Holmes and William Cain, 1893. 8°, 88 pp. *Out of print.*
5. The Forests, Forest Lands, and Forest Products of Eastern North Carolina, by W. W. Ashe, 1894. 8°, 128 pp., 5 pl. *Out of print.*
6. The Timber Trees of North Carolina, by Gifford Pinchot and W. W. Ashe, 1897. 8°, 227 pp., 22 pl. *Out of print.*
7. Forest Fires: Their Destructive Work, Causes and Prevention, by W. W. Ashe, 1895. 8°, 66 pp., 1 pl. *Out of print.*
8. Water powers in North Carolina, by George F. Swain, Joseph A. Holmes, and E. W. Myers, 1899. 8°, 362 pp., 16 pl. *Out of print.*
9. Monazite and Monazite Deposits in North Carolina, by Henry B. C. Nitze, 1895. 8°, 47 pp., 5 pl. *Out of print.*
10. Gold Mining in North Carolina and other Appalachian States, by Henry B. C. Nitze and A. J. Wilkins, 1897. 8°, 164 pp., 10 pl. *Out of print.*
11. Corundum and the Basic Magnesian Rocks of Western North Carolina, by J. Volney Lewis, 1895. 8°, 107 pp., 6 pl. *Out of print.*
12. History of the Gems Found in North Carolina, by George Frederick Kunz, 1907. 8°, 60 pp., 15 pl. *Out of print.*
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17. Terracing of Farm Lands, by W. W. Ashe, 1908. 8°, 38 pp., 6 pl., 2 figs. *Postage 4 cents.*
18. Bibliography of North Carolina Geology, Mineralogy, and Geography, with a list of Maps, by Francis Baker Laney and Katherine Hill Wood, 1909. 8°, 428 pp. *Postage 25 cents. Cloth-bound copy, $1.00.*
19. The Tin Deposits of the Carolinas, by Joseph Hyde Pratt and Douglas B. Sterrett, 1905. 8°, 64 pp., 8 figs. *Postage 4 cents.*
20. Waterpowers of North Carolina: An Appendix to Bulletin 8, 1910. 8°, 383 pp. *Postage 25 cents.*
21. The Gold Hill Mining District of North Carolina, by Francis Baker Laney, 1910. 8°, 137 pp., 23 pl., 5 figs. *Postage 15 cents. Cloth copies 75 cents.*

22. A Report on the Cid Mining District, Davidson County, N. C., by J. E. Pogue, Jr., 1911. 8°, 144 pp., 22 pl., 5 figs. *Postage 15 cents. Cloth copies 75 cents.*

23. Forest Conditions in Western North Carolina, by J. S. Holmes, 1911. 8°, 116 pp., 8 pl. *Postage 15 cents.*

24. Loblolly or North Carolina Pine, by W. W. Ashe, Forest Inspector, U. S. Forest Service (and former Forester of the North Carolina Geological and Economic Survey). Prepared in Coöperation with the Forest Service, U. S. Department of Agriculture, 1914. 8°, 176 pp., 27 pl., 5 figs. *Postage 15 cents. Cloth copies 75 cents.*

25. Zircon, Monazite, and Other Minerals used in the Production of Chemical Compounds Employed in the Manufacture of Lighting Apparatus, by Joseph Hyde Pratt, Ph.D., 1916. 8°, 120 pp., 3 pl. *Postage 15 cents. Cloth copies 75 cents.*

26. A Report on the Virgilina Copper District of North Carolina and Virginia, by F. B. Laney, Ph.D., 1917. 8°, 176 pp., 20 pl., 16 figs.

27. The Altitudes of North Carolina, 1917. 8°, 124 pp. *Postage 20 cents.*

28. Limestones and Marls of North Carolina, by G. F. Loughlin, E. W. Berry, and J. A. Cushman. Prepared by the United State Geological Survey in coöperation with the North Carolina Geological and Economic Survey, 1921. 8°, 211 pp., 7 pl., 3 figs. *Postage 15 cents.*

Gives a complete description of the various deposits of limestones and marls in North Carolina; the history of their production and use; describes plants now operating in the State, and discusses the possible future of limestones and marls as a fertilizer for North Carolina.

ECONOMIC PAPERS

1. The Maple Sugar Industry in Western North Carolina, by W. W. Ashe, 1897. 8°, 34 pp. *Postage 2 cents.*

2. Recent Road Legislation in North Carolina, by J. A. Holmes. *Out of print.*

3. Talc and Pyrophyllite Deposits in North Carolina, by Joseph Hyde Pratt, 1900. 8°, 29 pp., 2 maps. *Postage 2 cents.*

4. The Mining Industry in North Carolina, during 1900, by Joseph Hyde Pratt, 1901. 8°, 36 pp., and map. *Out of print.*

Takes up in some detail Occurrences of Gold, Silver, Lead and Zinc, Copper, Iron, Manganese, Corundum, Granite, Mica, Talc, Pyrophyllite, Graphite, Kaolin, Gem Minerals, Monazite, Tungsten, Building Stones, and Coal in North Carolina.

5. Road Laws of North Carolina, by J. A. Holmes. *Out of print.*

6. The Mining Industry in North Carolina During 1901, by Joseph Hyde Pratt, 1902. 8°, 102 pp. *Out of print.*

Gives a list of Minerals found in North Carolina; describes the Treatment of Sulphuret Gold Ores, giving localities; takes up the Occurrence of Copper in the Virgilina, Gold Hill, and Ore Knob districts; gives Occurrence and Uses of Corundum; a List of Garnets describing Localities; the Occurrence, Associated Minerals, Uses and Localities of Mica; the Occurrence of North Carolina Feldspar, with Analyses; an extended description of North Carolina Gems and Gem Minerals; Occurrences of Monazite, Barytes, Ocher; describes and gives Occurrences of Graphite and Coal; describes and gives Occurrences of Building Stones, including Limestone; describes and gives Uses for the various forms of clay, and under the head of "Other Economic Minerals," describes and gives Occurrences of Chromite, Asbestos, and Zircon.

7. Mining Industry in North Carolina During 1902, by Joseph Hyde Pratt, 1903. 8°, 27 pp. *Out of print.*

8. The Mining Industry in North Carolina During 1903, by Joseph Hyde Pratt, 1904. 8°, 74 pp. *Out of print.*

Gives description of Mines worked for Gold in 1903; description of Properties worked for Copper during 1903, together with assay of ore from Twin-Edwards Mine; analyses of Limonite ore from Wilson Mine, the Occurrence of Tin; in some detail the Occurrences of Abrasives, Occurrences of Monazite and Zircon; Occurrences and Varieties of Graphite, giving Methods of Cleaning; Occurrences of Marble and other forms of Limestone; Analyses of Kaolin from Barber Creek, Jackson County, North Carolina.

9. The Mining Industry in North Carolina During 1904, by Joseph Hyde Pratt, 1905. 8°, 95 pp. *Postage 4 cents.*

Gives Mines Producing Gold and Silver during 1903 and 1904, and Sources of the Gold Produced during 1904; describes the mineral Chromite, giving Analyses of Selected Samples of Chromite from Mines in Yancey County; describes Commercial Varieties of Mica, giving the manner in which it occurs in North Carolina, Percentage of Mica in the Dikes, Methods of Mining, Associated Minerals, Localities; Uses; describes the mineral Barytes, giving Method of Cleaning and Preparing Barytes for Market, describes the use of Monazite as used in connection with the Preparation of the Bunsen Burner, and goes into the use of Zircon in connection with the Nernst Lamp, giving a List of the Principal Yttrium Minerals; describes the minerals containing Corundum Gems, Hiddenite and Other Gem Minerals, and gives New Occurrences of these Gems; describes the mineral Graphite and gives new Uses for same.

10. Oyster Culture in North Carolina, by Robert E. Coker, 1905. 8°, 39 pp. *Out of print.*

11. The Mining Industry in North Carolina During 1905, by Joseph Hyde Pratt, 1906. 8°, 95 pp. *Out of print.*

Describes the mineral Cobalt and the principal minerals that contain Cobalt; Corundum Localities; Monazite and Zircon in considerable detail, giving Analyses of Thorianite; describes Tantalum Minerals and gives description of the Tantalum Lamp; gives brief description of Peat Deposits; the manufacture of Sand-lime Brick; Operations of Concentrating Plant in Black Sand Investigations; gives Laws Relating to Mines, Coal Mines, Mining, Mineral Interests in Land, Phosphate Rock, Marl Beds.

12. Investigations Relative to the Shad Fisheries of North Carolina, by John N. Cobb, 1906. 8°, 74 pp., 8 maps. *Postage 6 cents.*

13. Report of Committee on Fisheries in North Carolina. Compiled by Joseph Hyde Pratt, 1906. 8°, 78 pp. *Out of print.*

14. The Mining Industry in North Carolina During 1906, by Joseph Hyde Pratt, 1907. 8°, 144 pp., 20 pl., and 5 figs. *Postage 10 cents.*

Under the head of "Recent Changes in Gold Mining in North Carolina," gives methods of mining, describing Log Washers, Square Sets, Cyanide Plants, etc., and detailed descriptions of Gold Deposits and Mines are given; Copper Deposits of Swain County are described; Mica Deposits of Western North Carolina are described, giving Distribution and General Character, General Geology, Occurrence, Associated Minerals, Mining and treatment of mica, origin, together with a description of many of the mines; Monazite is taken up in considerable detail as to Location and Occurrence, Geology, including classes of Rocks, Age, Associations, Weathering, method of Mining and Cleaning, description of Monazite in Original Matrix.

15. The Mining Industry in North Carolina During 1907, by Joseph Hyde Pratt, 1908. 8°, 176 pp., 13 pl., and 4 figs. *Postage 15 cents.*

Takes up in detail Copper and the Gold Hill Copper District, a description of the Uses of Monazite and its Associated Minerals; descriptions of Ruby, Emerald, Beryl, Hiddenite, and Amethyst Localities; a detailed description with Analyses of the Principal Mineral Springs of North Carolina; a description of the Peat Formations in North Carolina, together with a detailed account of the uses of Peat and the Results of an Experiment Conducted by the United States Geological Survey on Peat from Elizabeth City, North Carolina.

16. Report of Convention called by Governor R. B. Glenn to Investigate the Fishing Industries in North Carolina, compiled by Joseph Hyde Pratt, State Geologist, 1908. 8°, 45 pp. *Out of print.*

17. Proceedings of Drainage Convention held at New Bern, North Carolina, September 9, 1908. Compiled by Joseph Hyde Pratt, 1908. 8°, 94 pp. *Out of print.*

18. Proceedings of Second Annual Drainage Convention held at New Bern, North Carolina, November 11 and 12, 1909, compiled by Joseph Hyde Pratt, and containing North Carolina Drainage Law, 1909. 8°, 50 pp. *Out of print.*

19. Forest Fires in North Carolina During 1909, by J. S. Holmes, Forester, 1910. 8°, 52 pp., 9 pl. *Out of print.*

20. Wood-using Industries of North Carolina, by Roger E. Simmons, under the direction of J. S. Holmes and H. S. Sackett, 1910. 8°, 74 pp., 6 pl. *Out of print.*

21. Proceedings of the Third Annual Drainage Convention, held under Auspices of the North Carolina Drainage Association; and the North Carolina Drainage Law (codified). Compiled by Joseph Hyde Pratt, 1911. 8°, 67 pp., 3 pl. *Out of print.*

22. Forest Fires in North Carolina During 1910, by J. S. Holmes, Forester, 1911. 8°, 48 pp. *Out of print.*

23. Mining Industry in North Carolina During 1908, '09, and '10, by Joseph Hyde Pratt and Miss H. M. Berry, 1911. 8°, 134 pp., 1 pl., 27 figs. *Postage 10 cents. Cloth copies 50 cents extra.*

Gives report on Virgilina Copper District of North Carolina and Virginia, by F. B. Laney; Detailed report on Mica deposits of North Carolina, by Douglas B. Sterrett; Detailed report on Monazite, by Douglass B. Sterrett; Reports on various Gem Minerals, by Douglas B. Sterrett; Information and Analyses concerning certain Mineral Springs; Extract from Chance Report of the Dan River and Deep River Coal Fields; some notes on the Peat Industry, by Professor Charles A. Davis; Extract from report of Arthur Keith on the Nantahala Marble; Description of the manufacture of Sand-lime Brick.

24. Fishing Industry of North Carolina, by Joseph Hyde Pratt, 1911. 8°, 44 pp. *Out of print.*

25. Proceedings of Second Annual Convention of the North Carolina Forestry Association, held at Raleigh, North Carolina, February 21, 1912. Forest Fires in North Carolina During 1911. Suggested Forestry Legislation. Compiled by J. S. Holmes, Forester, 1912. 8°, 71 pp. *Postage 5 cents.*

26. Proceedings of Fourth Annual Drainage Convention, held at Elizabeth City, North Carolina, November 15 and 16, 1911, compiled by Joseph Hyde Pratt, State Geologist, 1912. 8°, 45 pp. *Out of print.*

27. Highway Work in North Carolina, containing a Statistical Report of Road Work during 1911, by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 145 pp., 11 figs. *Out of print.*

28. Culverts and Small Bridges for Country Roads in North Carolina, by C. R. Thomas and T. F. Hickerson, 1912. 8°, 56 pp., 14 figs., 20 pl. *Postage 10 cents.*

29. Report of the Fisheries Convention held at New Bern, N. C., December 13, 1911, compiled by Joseph Hyde Pratt, State Geologist, together with a Compendium of the Stenographic Notes of the Meetings Held on the two trips taken by the Legislative Fish Committee Appointed by the General Assembly of 1909, and the Legislation Recommended by this Committee, 1912. 8°, 302 pp. *Postage 15 cents.*

30. Proceedings of the Annual Convention of the North Carolina Good Roads Association held at Charlotte, N. C., August 1 and 2, 1912, in Coöperation with the North Carolina Geological and Economic Survey. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1912. 8°, 109 pp. *Postage 10 cents.*

31. Proceedings of fifth Annual Drainage Convention held at Raleigh, N. C., November 26 and 27, 1912. Compiled by Joseph Hyde Pratt, State Geologist. 8°, 56 pp., 6 pl. *Postage 5 cents.*

32. Public Roads are Public Necessities, by Joseph Hyde Pratt, State Geologist, 1913. 8°, 62 pp. *Postage 5 cents.*

33. Forest Fires in North Carolina during 1912 and National and Association Coöperative Fire Control, by J. S. Holmes, Forester, 1913. 8°, 63 pp. *Postage 5 cents.*

34. Mining industry in North Carolina during 1911-12, by Joseph Hyde Pratt, State Geologist, 1914. 8°, 314 pp., 23 pl., 12 figs. *Postage 15 cents.*

Gives detailed report on Gold Mining in various counties with special report on Metallurgical processes used at the Iola Mine, by Claud Hafer; description of a Cyanide Mill by Percy Barbour; the new milling process for treating North Carolina Siliceous Gold Ores at the Montgomery Mine, including a description of the Uwarrie Mining Company's Plant; notes on the Carter Mine, Montgomery County, by Claud Hafer; also a description of the Howie Mine and its mill; a detailed report of the Coggins (Appalachian) Gold Mine, by Joseph Hyde Pratt; a list of gems and gem minerals occurring in the United States; special descriptions of Localities where the Amethyst, Beryl, Emerald, and Quartz Gems Occur, as taken from United States Geological Survey Report by Douglas B. Sterrett; a report on the Dan River Coal Field, by R. W. Stone, as reprinted from Bulletin 471-B of the United States Geological Survey, a special report on Graphite, by Edson S. Bastin and reprinted from Mineral Resources of United States for 1912; a special report on Asbestos describing both the Amphi-

bole and Chrysotile varieties; a report on the Mount Airy Granite Quarry; special report on Sand and Gravel, giving Uses, Definitions of Various Sands, etc., the portion of a Bulletin on Feldspar and Kaolin of the United States Bureau of Mines, which relates to North Carolina, and which takes up in detail Occurrences, Methods of Mining, and Descriptions of Localities of Feldspar and Kaolin mines in North Carolina, prepared by Mr. A. S. Watts. In this Economic Paper are also given the names and addresses of producers of the various minerals during the years covered by the report.

35. Good Road Days, November 5th and 6th, 1913, compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 102 pp., 11 pl. *Postage 10 cents.*

36. Proceedings of the North Carolina Good Roads Association, held at Morehead City, N. C., July 31st and August 1, 1913. In Coöperation with the North Carolina Geological and Economic Survey.—Statistical Report of Highway Work in North Carolina during 1912. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 127 pp., 7 figs. *Postage 10 cents.*

37. Forest Fires in North Carolina during 1913 and a Summary of State Forest Fire Prevention in the United States, by J. S. Holmes, Forester, 1914. 8°, 82 pp. *Postage 8 cents.*

38. Forms covering the Organization of Drainage Districts under the North Carolina Drainage Law, Chapter 442, Public Laws of 1909, and Amendments. And Forms for Minutes of Boards of Drainage Commissioners covering the Organization of the Board up to and Including the Issuing of the Drainage Bonds. Compiled by Geo. R. Boyd, Drainage Engineer, 133 pp.

39. Proceedings of the Good Roads Institute held at the University of North Carolina, March 17-19, 1914. Held under the auspices of the Departments of Civil and Highway Engineering of the University of North Carolina and the North Carolina Geological and Economic Survey. 8°, 117 pp., 15 figs., 4 pl. *Postage 10 cents.*

40. Forest Fires in North Carolina during 1914 and Forestry Laws of North Carolina, by J. S. Holmes, State Forester, 1915. 8°, 55 pp. *Postage 5 cents.*

41. Proceedings of Seventh Annual Drainage Convention of the North Carolina Drainage Association held at Wilson, North Carolina, November 18 and 19, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1915. 8°, 76 pp., 3 figs. *Postage 5 cents.*

42. Organization of Coöperative Forest Fire Protective Areas in North Carolina, being the Proceedings of the Special Conference on Forest Fire Protection, held as part of the Conference on Forestry and Nature Study, Montreat, N. C., July 8, 1915. Prepared by J. S. Holmes, State Forester, 1915. 8°, 39 pp. *Postage 4 cents.*

43. Proceedings of the Second Road Institute, held at the University of North Carolina, February 23-27, 1915. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1916. 8°, 128 pp. *Postage 15 cents.*

44. Highway Work in North Carolina During the Calendar Year Ending December 31, 1914. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1916. 8°, 55 pp. *Postage 10 cents.*

45. Proceedings of the Eighth Annual Drainage Convention. Held under the Auspices of the North Carolina Drainage Association and the North Carolina Geological and Economic Survey, Belhaven, N. C., November 29, 30, and December 1, 1915. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 8°, 90 pp. *Postage 15 cents.*

46. The Vegetation of Shackleford Bank, by I. F. Lewis, 1917. 8°, 40 pp., 11 pl. *Postage 10 cents.*

47. Proceedings of the Ninth Annual Drainage Convention of the North Carolina Drainage Association, held at Greensboro, N. C., November 22 and

23, 1916. Compiled by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1917. 8°, 110 pp., 8 figs. *Postage 15 cents.*

48. Forest Fires in North Carolina during 1915, 1916 and 1917, and Present Status of Forest Fire Prevention in North Carolina, by J. S. Holmes, State Forester, 1918. 8°, 97 pp. *Postage 10 cents.*

49. Mining Industry in North Carolina during 1913-1917, Inclusive, by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary, 1919. 8°, 170 pp. *Postage 20 cents.*

Gives list of useful minerals of North Carolina; contains detailed report on the Uwarra Mill at Candor; data relating to the brown hematite iron ores and a special report on the titaniferous iron ores of the State; report on tin resources of the Kings Mountain District; special data relating to manganese; greensand; marble deposits of Cherokee County; clay tests.

50. Proceedings of Tenth Annual Drainage Convention, held at Washington, North Carolina, March 31 and April 1, 1920, compiled by North Carolina Geological and Economic Survey, 1920. 8°, 78 pp. *Postage 10 cents.*

51. Forest Fires in North Carolina During 1918, 1919, and 1920, and Forest Protection in North Carolina, by J. S. Holmes, State Forester, 1921. ....°, ...pp. *Postage 10 cents.*

VOLUMES

Vol. I. Corundum and the Basic Magnesian Rocks in Western North Carolina, by Joseph Hyde Pratt and J. Volney Lewis, 1905. 8°, 464 pp., 44 pl., 35 figs. *Postage 32 cents. Cloth-bound copy $1.50 extra.*

Vol. II. Fishes of North Carolina, by H. M. Smith, 1907. 8°, 453 pp., 21 pl., 188 figs. *Out of print.*

Vol. III. The Coastal Plain Deposits of North Carolina, by William Bullock Clark, Benjamin L. Miller, L. W. Stephenson, B. L. Johnson, and Horatio N. Parker, 1912. 8°, 509 pp., 62 pl., 21 figs. *Out of print.*

Pt. I.—The Physiography and Geology of the Coastal Plain of North Carolina, by Wm. Bullock Clark, Benjamin L. Miller and L. W. Stephenson.
Pt. II.—The Water Resources of the Coastal Plain of North Carolina, by L. W. Stephenson and B. L. Johnson.

Vol. IV. The Birds of North Carolina, by T. Gilbert Pearson, C. S. Brimley and H. H. Brimley, 1918. 8°, 380 pp., 24 colored plates, 10 black and white plates, 275 text figures, one map. *Paper copies, $2.00, postpaid. Cloth-bound copies, $2.75, postpaid.*

BIENNIAL REPORTS

First Biennial Report, 1891-1892, J. A. Holmes, State Geologist, 1893. 8°, 111 pp., 12 pl., 2 figs. *Postage 6 cents.*

Administrative report, giving object and organization of the Survey; Investigations of Iron Ores, Building Stone, Geological work in Coastal Plain Region, including supplies and drinking waters in eastern counties, Report on Forests and Forest Products, Coal and Marble, Investigations of Diamond Drill.

Biennial Report, 1893-1894, J. A. Holmes, State Geologist, 1894. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1895-1896, J. A. Holmes, State Geologist, 1896. 8°, 17 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1897-1898, J. A. Holmes, State Geologist, 1898. 8°, 28 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1899-1900, J. A. Holmes, State Geologist, 1900. 8°, 20 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1901-1902, J. A. Holmes, State Geologist, 1902. 8°, 15 pp. *Postage 1 cent.*

Administrative report.

Biennial Report, 1903-1904, J. A. Holmes, State Geologist, 1905. 8°, 32 pp. *Postage 2 cents.*

Administrative report.

Biennial Report, 1905-1906, Joseph Hyde Pratt, State Geologist, 1907. 8°, 60 pp. *Postage 3 cents.*

Administrative report; report on certain swamp lands belonging to the State, by W. W. Ashe; it also gives certain magnetic observations at North Carolina stations.

Biennial Report, 1907-1908, Joseph Hyde Pratt, State Geologist, 1908. 8°, 60 pp., 2 pl. *Postage 5 cents.*

Administrative report. Contains Special Report on an examination of the Sand Banks along the North Carolina Coast, by Jay F. Bond, Forest Assistant, United States Forest Service; certain magnetic observations at North Carolina stations; Results of an Investigation Relating to Clam Cultivation, by Howard E. Enders, of Purdue University.

Biennial Report, 1909-1910, Joseph Hyde Pratt, State Geologist, 1911. 8°, 152 pp. *Postage 10 cents.*

Administrative report, and contains Agreements for Cooperation in Statistical Work, and Topographical and Traverse Mapping Work with the United States Geological Survey; Forest Work, with the United States Department of Agriculture (Forest Service); List of Topographic maps of North Carolina and counties partly or wholly topographically mapped; description of Special Highways in North Carolina; suggested Road Legislation; list of Drainage Districts and Results of Third Annual Drainage Convention; Forestry Reports relating to Connolly Tract, Buncombe County and Transylvania County State Farms; certain Watersheds; Reforestation of Cut-over and Abandoned Farm Lands on the Woodlands of the Salem Academy and College; Recommendations for the Artificial Regeneration of Longleaf Pine at Pinehurst, Act regulating the use of and for the Protection of Meridian Monuments and Standards of Measure at the several county seats of North Carolina; list of Magnetic Declinations at the county seats, January 1, 1910; letter of Fish Commissioner of the United States Bureau of Fisheries relating to the conditions of the North Carolina fish industries; report of the survey for the North Carolina Fish Commission referring to dutch or pound-net fishing in Albemarle and Croatan sounds and Chowan River, by Gilbert T. Rude, of the United States Coast and Geodetic Survey; Historical Sketch of the several North Carolina Geological Surveys, with list of publications of each.

Biennial Report, 1911-1912, Joseph Hyde Pratt, State Geologist, 1913. 8°, 165 pp. *Postage 7 cents.*

Administrative report, and contains reports on method of construction and estimate of cost of road improvement in Stantonsburg Township, Wilson County; report on road conditions in Lee County; report on preliminary location of section of Spartanburg-Hendersonville Highway between Tryon and Tuxedo; report of road work done by United States Office of Public Roads during biennial period; experiments with glutrin on the sand-clay road, report on Central Highway, giving Act establishing and report of trip over the Highway; suggested road legislation; report on the Asheville City watershed; report on the Struan property at Arden, Buncombe County; report on the Woodlands on the farm of Dr. J. W. Kilgore, Iredell County; report on examination of the woodlands on the Berry place, Orange County; report on the forest property of Miss Julia A. Thorns, Ashboro, Randolph County; report on the examination of the forest lands of the Butters Lumber Company, Columbus County; proposed forestry legislation; swamp lands and drainage, giving drainage districts, suggested drainage legislation; proposed Fisheries Commission Bill.

Biennial Report, 1913-1914, Joseph Hyde Pratt, State Geologist, 1915. 8°, 118 pp. *Postage 10 cents.*

Administrative report, and contains reports on the work of the State convicts on Hickory Nut Gap Road, Henderson County, and on the link of the Central Highway in Madison County which is being constructed with State convicts; report on road work accomplished by the State Survey and by the United States Office of Public Roads during biennial period; suggested road legislation; a forestry policy for North Carolina; report on investigation; timber supply of North Carolina; reports on the examination of certain forest lands in Halifax County; report on the ash in North Carolina; report on the spruce forests of Mount Mitchell; report on the forest fire conditions in the Northeastern States, by J. S. Holmes; Report on the work of the United States Forest Service in North Carolina in connection with the purchase of forest reserves and their protection; timber tests, including strength of timber, preservation of timber, timber suitable to produce pulp, distillation of certain woods and drying certain woods; suggested forestry legislation; report on the swamp lands and their drainage in North Carolina; suggested drainage legislation; report on magnetic observations made

during biennial period; report on the economic value of the fisheries of North Carolina; report on the survey made in Albemarle, Croatan, and Pamlico sounds by the Coast and Geodetic Survey; suggested fisheries legislation.

Biennial Report, 1915-1916, Joseph Hyde Pratt, State Geologist, 1917. 8°, 202 pp. *Postage 25 cents.*

Administrative report, and contains special reports on the Protection from Fire of the Forested Watersheds of Navigable Streams; National Forest Reservations; forestry report on Lake Latham Farms near Mebane, N. C.; report on Forest Tract owned by the Cranberry Iron and Coal Company near Cranberry, N. C.; report on work of N. C. Forestry Association; report on Southern Forestry Congress; special report on "The Fisheries of North Carolina"; Magnetic Observations made during 1915 and 1916; Memorial Sketch of Dr. Joseph Austin Holmes.

Biennial Report, 1917-1918, Joseph Hyde Pratt, State Geologist, 1919. 8°, 110 pp. *Postage 15 cents.*

Administrative Report, and contains special reports on the Mitchell State Park; Proposed Forestry Course at the State University; North Carolina Forestry Association; report on magnetic observations made during biennial period.

Biennial Report, 1919-1920, Joseph Hyde Pratt, Director and State Geologist, 1921. 8°, 74 pp. *Postage 10 cents.*

Administrative Report, and contains special reports on the present forest area of North Carolina and estimated amount and value of standing timber; on plan for water resource survey of the State; and on organization of Biological Division of the Survey.

Samples of any mineral found in the State may be sent to the office of the Geological and Economic Survey for identification, and the same will be classified free of charge. It must be understood, however, that NO ASSAYS OR QUANTITATIVE DETERMINATIONS WILL BE MADE. Samples should be in a lump form if possible, and marked plainly on outside of package with name of sender, postoffice address, etc.; a *letter* should accompany sample and *stamp* should be enclosed for reply.

These publications are mailed to libraries and to individuals who may desire information on any of the special subjects named in most cases free of charge, except that in each case applicants for the reports should forward the amount needed for packing and transportation for mailing the bulletins desired, to the *State Geologist, Chapel Hill, N. C.*

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, Director

ECONOMIC PAPER No. [illegible]

PROCEEDINGS

OF THE

ELEVENTH ANNUAL DRAINAGE CONVENTION

HELD AT

ELIZABETH CITY, NORTH CAROLINA
APRIL 12 AND 13, 1921

Compiled by

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, Director

ECONOMIC PAPER No. 52

PROCEEDINGS

OF THE

ELEVENTH ANNUAL DRAINAGE CONVENTION

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Compiled by

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

RALEIGH
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GEOLOGICAL BOARD

LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., June 1, 1921.

To His Excellency, HON. CAMERON MORRISON,

Governor of North Carolina.

SIR:—The Eleventh Annual Drainage Convention of North Carolina was held at Elizabeth City, April 12 and 13, 1921, under the auspices of the North Carolina Geological and Economic Survey and the North Carolina Drainage Association.

On account of the interest throughout this State in all matters relating to reclamation of our swamp and overflowed lands, it is believed that the papers presented at this Convention are of sufficient importance to warrant their being published with the proceedings of the Convention and distributed throughout the State. It is therefore recommended that the proceedings and all papers of this Convention be published by the Survey as Economic Paper No. 52 of the publications of the North Carolina Geological and Economic Survey.

Yours respectfully,

JOSEPH HYDE PRATT, *Director,*

North Carolina Geological and Economic Survey.

CONTENTS

Proceedings of the Eleventh Annual Convention of the North Carolina Drainage Association

Elizabeth City, North Carolina, April 12 and 13, 1921

TUESDAY, APRIL 12—Morning Session

HON. JOHN H. SMALL, President of the Association, Presiding.

The Eleventh Annual Convention of the North Carolina Drainage Association was opened in Elizabeth City, North Carolina, at 10:30 a.m., April 12, in the assembly room of the Chamber of Commerce, the meeting being called to order by the President, Hon. John H. Small. The session was opened with prayer by the Reverend J. M. Ormond of Elizabeth City, and addresses of welcome were delivered by Mr. J. C. B. Ehringhaus on behalf of the city, and by Hon. Walter L. Cohoon for the Chamber of Commerce.

Mr. Ehringhaus spoke as follows:

Elizabeth City is glad to have you here today. Elizabeth City welcomes you to her borders. We expect to derive a great deal of profit and pleasure from your stay among us, and we trust that when you shall go away you will carry with you a recollection of these hours and days spent with us, not only as having been full of profit from your associations here, but a pleasant recollection of this, the Queen City of the Albemarle section. We are given to boast a little today of our town. We take a pardonable pride in her position. It is the cradle of North Carolina; it is the center of all counties in Eastern North Carolina because it is so located geographically—this city of ours—that the adjoining counties naturally come to us as the center of their industrial and commercial activities. Elizabeth City boasts of many things, but she lacks a great many things; of that we are all sensible. And you, my friends, are welcome in our midst today because we recognize in your Association, and in you as members of that Association, men who have given of their time and efforts to a concerted effort to the better things of the State which we all love. We trust and believe that your stay here will be full of pleasure to yourselves, as well as profit. Anything in the world that the town owns and possesses is yours!

I was very much interested to find that this is the first visit of the Commissioner of Agriculture of North Carolina to Elizabeth City. I trust that it will not be his last, and I hope, too, that those of you who have not been here before will make it a point to come again. There is much for us both in continued associations.

Now, each and every citizen of this town bids you welcome, hopes you will feel at home among us—not as strangers, but as friends and brothers—and trusts that you will have a most enjoyable time while you are here.

The response to the addresses of welcome was made by Hon. John H. Small, President of the Association, who spoke as follows:

RESPONSE TO THE ADDRESSES OF WELCOME

The pleasure of responding to these very cordial addresses of welcome is emphasized by the fact that I not only express the individual sentiment of your presiding officer, but that I speak in a representative capacity for the members and delegates of the North Carolina Drainage Association. When a stranger comes to the home of a friend, his pleasure is much intensified if he has the glad hand of welcome extended to him and in cheery tones his host says, "Feel at home"; and when an association meeting from year to year in different cities convenes for a new meeting it is fitted better for the discharge of its duties because the membership is made contented and are pleased in spirit if a sincere welcome awaits them. We are confident that this welcome upon the part of the municipality and of this most active civic association, the Chamber of Commerce, are expressed in terms of sincerity, and, therefore, we are all the more appreciative.

I am in sympathy with what these gentlemen have said about Elizabeth City—first as to the fact that it is the northeasternmost town of any size in North Carolina, and because geographically it has for years been isolated from the remainder of the State. As a boy I recall when this railroad, now the Norfolk Southern, had been constructed only to Elizabeth City, how remote it was regarded by the people who lived even upon the south side of the Albemarle Sound, and how even in church affairs it was affiliated with another state rather than with its own State. Elizabeth City has been brought more nearly to the remainder of the State during these recent years by the extension of the railroad and by increased facilities of transportation by water, and now the proposed highway to Gates County, and thence to the balance of the State, affords a prospect of even better acquaintance.

But in spite of these handicaps, Elizabeth City has grown, and its growth has been distinctive. It is generally assumed that towns located near large cities are overshadowed and handicapped by their big neighbors. If any foundation ever existed for such a proposition, Elizabeth City has demonstrated its falsity. For three decades at least its growth has been steady and wholesome. In commerce, in manufactures, in the various organizations which make for religious and social betterment, it has constantly grown.

Agriculture, through the adoption of better methods and more intelligent supervision, has increased both in volume of production and quality of product; and I think it is fair to say that along with the remarkable rural and agricultural growth in North Carolina no section has shown a more marked progress than these counties in this northeastern section, which might be described as tributary to this metropolis of Northeastern North Carolina.

If Major Graham is making his first visit to Elizabeth City, and if any of you have that pleasure in common with him, you are to be congratulated that while the pleasure may have been postponed, the contentment which it brings to you and the discoveries which you make will at least justify the delay.

Speaking on behalf of the members and delegates of the Association, I again thank these gentlemen representing the municipality and the Chamber of Commerce for the very cordial and sincere words of welcome that they have extended us.

REPORTS OF OFFICERS

REPORT OF THE PRESIDENT

Following his response to the addresses of welcome, Mr. Small made his presidential address, as follows:

REVIEW OF RECLAMATION WORK IN NORTH CAROLINA

BY HON. JOHN H. SMALL

Several thoughts, as you will observe after I have concluded, are prominent in my mind this morning in connection with the work of the Association: First, as to its accomplishments. I shall not detain you with a recital of the achievements of the North Carolina Drainage Association since its first meeting in the city of New Bern in 1908. Briefly stated, those achievements are the preparation and enactment of the drainage law, one of the most constructive pieces of legislation in the last two decades. The drainage law was prepared by a committee of your Association, of which your speaker was the chairman and in which he had a large part. It was the first modern drainage law in any southern state except Louisiana—and it is a compliment to this Association that since 1909 Virginia, South Carolina, Georgia, Florida, and Mississippi have enacted drainage laws substantially similar to the North Carolina law. The original drainage law in Louisiana was one which had existed for many years, founded upon the French code, as all Louisiana laws are; but it recognizes the outstanding principle in all modern drainage laws, the necessity for coöperation among various landowners whose lands may be drained to a common outlet.

About six hundred thousand acres of land in districts whose work has been completed have been reclaimed and thus added to the wealth of the State, increasing our productive capacity, adding to the taxable wealth, and constituting a very definite factor in the economic growth of North Carolina during this last decade.

But, with all that has been accomplished, there is still much to be done; in fact, we have only made a substantial beginning. There are yet many hundreds of thousands of acres of cutover swamp lands just as fertile as those which have been subjected to the plough, and which in the process of time and the spread of knowledge regarding the work of the drainage law and the profitable results from the drainage of these lands, will be added to the reclaimed area and bring additional wealth to the State.

The first thought which I desire to present and, in so far as I may, to emphasize, is the necessity of extending this drainage movement so that we shall begin the formation of drainage districts composed of cultivated lands. In this Coastal Plain section of the State with its low-lying level and slight elevation above tidewater—the oldest in the history of the development of the State—we have at the same time many hundreds of thousands of acres of cultivated lands, many of which have been cultivated for a hundred years, and some for a hundred and fifty years, which are uncertain in crop production because they have not been effectively drained; and they will never be efficiently drained by the invidual work of the owner. They cannot be drained except the water upon them is taken to some ultimate outlet. Such large outlet canal may cross the lands of a dozen or more farmers. The cost would be prohibitive for any one farmer. The only solution lies in coöperative effort under the provisions of the drainage law.

Having gone in and out among the homes of our people for many years, I speak from actual knowledge of the necessity for more effective drainage for the bulk of our cultivated lands. May I give you just one illustration which will strike a familiar note in your memory? I have heard my friends during May and June, and perhaps until the middle of July, report fine crops, with just enough sunshine and moisture for plant growth; and yet excessive rains would follow and they would report that their crops had been "drowned out." If I may make a rough calculation, I would say that the crops on many of these farms are destroyed or "drowned out" at least once in five years. Some of our best alluvial lands can only be relied upon for a full crop one or two years out of five. That is an unwise, unprofitable way in which to prosecute in any business; and we who know something of the benefits and necessity of drainage and the way by which it must be secured should make ourselves the ambassadors of progress and go among our people and preach to them the gospel of better drainage of their lands, and in doing so we will add immeasurably to their productive value, to the prosperity of the individual owners, and to the increased wealth of our State.

Ladies and gentlemen, what are some of the essentials for greater progress in drainage, as well as in some of the other economic movements in North Carolina? How may we obtain good roads; better schools; more commodious and progressive and consecrated churches; and better health conditions? How may we accelerate the movement for more and a better grade of livestock? What are some of the handicaps—and some of the essentials by which we may increase progress in these various movements?

First, as to the handicaps: One might suggest, first, a lack of intelligence and a prevalence of ignorance. The very first result of increased intelligence is the willingness and the capacity to recognize and admit our faults. The more ignorant a man is (and that applies to all of us), the more he is inclined to attribute his shortcomings and failures to some one else rather than to himself. The great bard expressed the thought that "It is not in our stars, but in ourselves, that we are underlings." A friend may criticise without offense, provided he is sincere. Ignorance is one of our serious handicaps which retards the movement for progress, whether spiritual or material.

There is a lack of mutual confidence among our people. A man ought to be wordly wise. To quote from the Good Book, he should be "as wise as a serpent and harmless as a dove"; but he should extend confidence where it is deserved.

The great bulk of these movements for progress require coöperation and confidence one toward another. We have emphasized in North Carolina too long a kind of self-conscious individualism. We need to broaden that into a spirit of service in which we shall be willing to consecrate a good part of ourselves and our hearts and minds to the cause of humanity and progress. And we cannot do that if we withhold confidence, because confidence is the basis of coöperation. I was talking recently to a wealthy man in the city of New York, and he said: "If you withdraw confidence from the financial and commercial affairs of the world, business would stop." Confidence must be extended where the recipient is worthy of confidence. Leadership of the kind that is blessed with intelligence and with the spirit of service and with a pleasing personality begets confidence. A leader of that kind in any community is more precious than gold, because his value cannot be expressed in dollars and cents. Where there is a consecrated leader of that kind, he ought to have, and is entitled to, the support of the good men and women of the community.

I must not detain you along this line for fear you may charge me with pessimism. I am not a pessimist. I am an optimist. But while following the bright light which the optimist loves to follow, we must not be blind to the

byways and hedges, but must endeavor to remove them. Let us in the spirit of intelligence and mutual confidence enlist more actively in the drainage of our wet lands. I think the Good Book says "Let him who would be great among you, be your seryant," and no man has ever come to be great until he has learned to follow or to be a servant. Let us cultivate all of these qualities among our people, and the car of progress will be accelerated and the growth of our people and the welfare of the State will become a matter of pride to North Carolinians everywhere.

Ladies and gentlemen, may I present just this further thought: We need more people in North Carolina from the outside. This has been demonstrated in many ways, including this movement for the drainage of our wet lands. We have reclaimed more land which is now ready to be cultivated than we have home settlers to demand it. I have no prejudices against any man or his family from any other section. The only test I would apply would be as to his intelligence, character, and loyalty. If the selection rested with me I would rather favor settlers from New England, the Middle States, or the Mississippi Valley; but from whatever section they come, if they are good men who wish to make the best of conditions and help us build up, I would invite and welcome them. How may we obtain these people? Our activities in seeking immigration in the past have been sporadic and ineffective. I am almost inclined to the opinion that the best results can be obtained by private effort. I have great faith in organized real estate agencies.

We need more men, not only to make homes, but to become part of our citizenship. The infusion of new blood makes for the betterment of the stock and for greater economic development. We have an illustration right here in Elizabeth City. I cannot recall another town in North Carolina which has received more benefit from the settlement among it of substantial men and women from other states than Elizabeth City. They have made themselves a part of your citizenship. Elizabeth City is a conspicuous example of the good results that come from the introduction of a fine type of settlers.

In inducing these strangers here to settle among us, we must remember to do the things that will make them feel at home, and the only guide necessary is the golden rule—to do by them just as you would like to be done by if you moved to the State of Virginia, or any other state. Let them worship God just as they please, have their own political beliefs, and think and speak just as they please. Let them be free American citizens in every respect. In our churches, civic organizations, in the various social activities, let them be made to feel that they are a part and parcel of us; and if there is any good in them, they will respond to this treatment and make all the better citizens and a larger contribution to the common welfare.

Just this one thought in conclusion: Whose duty is it to make this drainage movement a success? Whose duty is it to keep moving this activity for better and greater length of highways? To provide better schools, both in our towns and rural communities? To get behind that most essential and protective movement for better health, and particularly in our rural sections? Whose duty is it to strive in everything that makes for better civilization; a better life in this world and a finer prospect for the future? Whose duty is it to seek for rural betterment? In that connection may I ask the privilege of saying a word to the men and women who live in the town? Every town in Eastern North Carolina has an interest in every farm in the State, and particularly those which are contiguous to and tributary to that town. So far in the future as we may peer, Eastern North Carolina is to be agricultural; farming will be its chief industry. We may add our manufacturing enterprises, and it is to be hoped we will; but the products of the soil of various kinds will for generations to come be larger in volume and value than all the

other products from every other source, and that means that Elizabeth City and every other urban community will be dependent upon the soil. It is the duty of the men and women who live in the towns, men and women of intelligence, men and women who have devoted some of their lives to service, to take an interest in these rural problems. It is no discredit to the rural community to say that the town has perhaps a broader intelligence, because in the past they have enjoyed better opportunities. The better equipped we are to serve, the greater is the obligation. The Good Book says "Of him to whom much is given, much will be expected," and whenever we are blessed with trained minds and strong bodies fitted for the daily task, we should consecrate these talents to human service. The man in the town is under obligation to work for the welfare of the man on the farm.

There are comparatively few of us gathered together at this meeting this morning, and yet we are among the elect; and though few in number, we can carry into the other sections of North Carolina the lessons which we will learn at this meeting of the North Carolina Drainage Association. I am sure that the meeting will be a success; I believe that each man will at the end be glad to say he has been benefited; and that you will go back to your homes strenghtened in your beliefs and purposes and determined to devote even more of your time to the cause of drainage in North Carolina, as well as to those other social and civic movements which make for the public welfare.

The President then called for the report of the Secretary and Treasurer.

REPORT OF THE SECRETARY

JOSEPH HYDE PRATT

The Tenth Annual Convention of the North Carolina Drainage Association was held at Washington, North Carolina, March 31 and April 1, 1920. The proceedings of this Convention have been published as Economic Paper No. 50 of the publications of the North Carolina Geological and Economic Survey, and this Economic Paper is herewith submitted and distributed as the Secretary's report of that meeting.

The Secretary desires to take this opportunity to sketch briefly the work that has been done in reclaiming our swamp and overflowed lands and to call attention to the problems that still confront the Association.

About fifteen years ago there were in the eastern part of North Carolina approximately 3,000,000 acres of swamp lands, and from 60 to 75 per cent of the remaining lands of the Coastal Plain region, although being used for farm lands, were low and wet, and consequently producing only about half crops. Soon after the reorganization of the North Carolina Geological and Economic Survey in 1905, which resulted in an extension of its duties, the problem of draining the swamp and flat lands of Eastern and the overflowed lands of Piedmont North Carolina was taken under consideration. One of the first projects undertaken by the Survey was the drainage of certain lands in Beaufort County. This project demonstrated that much of the swamp area of the State could be reclaimed, and would make good agricultural lands when reclaimed; but there were no adequate laws in the State that would warrant or permit individuals undertaking drainage projects except on a very small scale on their own farms.

Realizing these conditions, and also realizing what it would mean to Eastern North Carolina if these swamp areas were drained, the Director of the Geo-

logical Survey called a meeting of all interested persons in New Bern on September 9, 1908. At this meeting the many problems connected with drainage and reclamation work were discussed by the State Geologist, who presided at the meeting, by Senator Simmons, by Congressmen Small, Godwin, Thomas, and Ward, and by engineers from the United States Department of Agriculture, and others. As a result of this meeting, the North Carolina Drainage Association was organized and a recommended drainage law was drafted, which the General Assembly of 1909 passed without a single amendment. This law has proven most effective in North Carolina and has been adopted practically without change by Virginia, South Carolina, Georgia, Florida, and probably other southern states. The law has been amended in certain minor respects to overcome difficulties that could not be foreseen at the time of its passage. At the recent session of the Legislature an amendment was passed definitely declaring drainage districts political subdivisions of the State, so that now there can be no question about the exemption of drainage bonds from Federal income and other taxes. This amendment should strengthen the market for North Carolina drainage and reclamation bonds and thus give an added impetus to the already fine results achieved under the operations of this law.

MORE THAN ONE HUNDRED AND FIFTY PROJECTS

The North Carolina Geological and Economic Survey has largely had charge of the administration of this law. Under the drainage law more than 150 projects have been organized or proposed. Of this number, more than fifty have been districts embracing overflowed lands in the Piedmont section, including lands in Burke, Cabarrus, Catawba, Cleveland, Davidson, Forsyth, Gaston, Guilford, Iredell, Lincoln, Mecklenburg, Moore, Rockingham, and Rowan counties; more than one hundred have been districts in the Coastal Plain region, mostly swamp lands in Beaufort, Bladen, Camden, Carteret, Chowan, Columbus, Craven, Cumberland, Currituck, Duplin, Edgecombe, Harnett, Hyde, New Hanover, Onslow, Pamlico, Pender, Perquimans, Pitt, Robeson, Sampson, Tyrrell, Washington, Wayne, and Wilson counties. Of these projects, seventy-five districts have been completed; twenty have been approved; sixty-one have been proposed and are either in the preliminary stages of organization or are held up for one reason or another; while nine have been abandoned as not feasible at the present time. The most stupendous single project was the drainage of Mattamuskeet Lake, which embraced over 100,000 acres and had to be drained by pumping the water out, as the bottom of the lake was below sea-level. The Ohio banking house that drained the lake has the lake bottom now in a state of development. A model town is being built, roads constructed, and a part of the land is being made ready for cultivation. In all, more than $2,000,000 is being spent on the development of this one project.

INCREASED VALUE OF LANDS

Approximately 30,000 acres in the Piedmont region have been successfully drained. This land is now the best farming land in the Piedmont region and is worth from $100 to $200 per acre as against a value of from $20 to $25 per acre before drainage. This means an aggregate increase in the value of the reclaimed lands in the Piedmont section of the State of from $225,000 to $300,000, to say nothing of the added healthfulness and attractiveness of this region. In the Coastal Plain region over a half million acres of swamp lands have been drained which now have an average value of from $50 to $100 per acre as against a value of from 50c to $2.00 per acre before drainage, or an aggregate increase in value of from thirty to fifty million dollars.

The increased value of these reclaimed areas from a health standpoint would more than offset what it has cost to drain them; but, from a commercial point of view, this is the least benefit that has been derived. These reclaimed lands are now recognized as the richest lands in the State. They will grow almost any kind of crops without fertilizer, including corn, cotton, grain, hay, potatoes, and truck crops, and the yield per acre is without parallel. In certain sections specialized crops can be grown, as, for instance, strawberries in Pender and Columbus counties, where it is reported that this land is selling for as much as $1,000 per acre. Tobacco has been successfully grown on certain of these lands in other counties. Report comes from Beaufort County that one tract of reclaimed swamp land containing about 100 acres has been rented for the coming year for $100 per acre for growing potatoes. A recent communication in regard to New Hanover County Drainage District No. 1 states:

"This district has been completed about twelve months. Not only in an agricultural way are they reaping great rewards, but it has developed into a suburban territory. Homes are being built upon it. Already thirteen have gone up, each of which represents an expenditure of from two to four thousand dollars."

Part of a letter from the Big Cold Water District of Cabarrus County in Piedmont North Carolina reads:

"As much as seventy bushels of corn per acre have been raised on the drained lands of this district without fertilizer. From the health standpoint the drainage has been a remarkable success. Malaria and chills have decreased, so the doctors say, 75 per cent. . . . "

ACCESSIBILITY TO MARKETS

In addition to the fertile soil, the production of phenomenal crops, and the almost complete abolition of chills, malaria, and fever, these reclaimed lands have the advantage of being accessible to markets. With the development of a State system of highways such as is contemplated under the operations of the newly enacted law, a more ideal farming section cannot be found anywhere than right here in North Carolina on the swamp and overflowed lands that have been drained. Most of the lands that have been drained are as yet unsettled, and the question of how best to bring them to the attention of desirable homeseekers is one of the biggest problems following their drainage. This subject will constitute one of the chief topics for discussion at the coming convention.

MUCH YET TO BE DONE

Although the progress made in drainage and reclamation work in the State has been wonderful, yet there is still a great deal to be done. More than 2,000,000 acres of swamp lands in Eastern North Carolina yet remain undrained, of which at least 1,250,000 can be successfully drained and will make agricultural land as productive as that already under cultivation. The people in this region are proceeding with the work. Every few days requests come to the Geological and Economic Survey for information in regard to the formation of districts, in regard to methods of procedure under the drainage law, requesting that an engineer be appointed, and similar information. Only a few days ago an attorney for a district in Duplin County wrote:

"I am filing a petition in Duplin County for the drainage of Stewart's Creek and its tributaries. The district will be named 'Duplin County Drainage District, No. 2.' I am working up several other drainage districts, and will let you hear from me from time to time."

THE USE OF TILE

The subject of tile drainage has not yet received the attention that it merits. It is estimated that from 60 to 75 per cent of the lands now under cultivation in the Coastal Plain region, not counting the drained swamp lands, could be greatly improved as agricultural land by the use of tile. The fact that the land is too wet and that its drainage is inadequate is indicated by water standing on it after rains, by the hardening and cracking of the surface after it dries, by it breaking up into cakes and clods when ploughed, and by the growth of plants commonly found in wet places. More has not been done in the way of tile drainage because the lands can be cultivated as they are, and the farmers do not realize the significance of tile drainage or feel inclined to go to the expense that would necessarily be involved in putting it in. Tile drainage must be done largely by single individuals. It costs more per acre than the drainage of the swamp lands costs. However, the tiling of these low wet lands would at least double their productivity and at the same time greatly reduce the amount of labor necessary to cultivate them. The State Department of Agriculture is interested in tile drainage, and Commissioner Graham and one or two of his drainage engineers are at this convention to lead a discussion on this subject.

In addition to tile drainage and the bringing of desirable settlers to North Carolina to take up the reclaimed areas, the maintenance of drainage ditches and canals, and the marketing of drainage bonds, are problems that still confront the Association.

It is hoped that this brief sketch of the progress and results of reclamation work in North Carolina will serve to stimulate still more interest in the continuance of this great undertaking, and that, when published, it may possibly come to the attention of people outside the State who may be interested in taking up some of these lands.

The General Assembly of North Carolina of 1921 passed one amendment to the North Carolina Drainage act, as follows:

AN ACT TO AMEND CHAPTER 94 OF THE CONSOLIDATED STATUTES OF NORTH CAROLINA, ENTITLED "DRAINAGE."

The General Assembly of North Carolina do enact:

SECTION 1. That section 5312 of the Consolidated Statutes of North Carolina be and the same is hereby amended so as to read as follows: "The clerk of the Superior Court of any county in the State of North Carolina shall have jurisdiction, power and authority to establish levee or drainage districts, either wholly or partly located in his county, and which shall constitute a political subdivision of the State, and to locate and establish levees, drains or canals, and cause to be constructed, straightened, widened, or deepened, any ditch, drain or watercourse, and to build levees or embankments and erect tidal gates and pumping plants for the purpose of draining and reclaiming wet, swamp, or overflowed land; and it is hereby declared that the drainage of swamp lands and the drainage of surface water from agricultural lands and the reclamation of tidal marshes shall be considered a public use and benefit and conducive to the public health, convenience, utility, and welfare, and that the districts heretofore and hereafter created under the law shall be and constitute political subdivisions of the State, with authority as provided by law to levy taxes and assessments for the construction and maintenance of said public works."

SEC. 2. That section 5360 thereof be amended by adding at the end of said section the following words: "That the State having authorized the creation of drainage districts, and having delegated thereto the power to levy a valid tax

in furtherance of the public purposes thereof, it is hereby declared that drainage districts heretofore or hereafter organized under existing law or any subsequent amendments thereto are created for a public use and are political subdivisions of the State.

SEC. 3. That this act shall be in force from and after its ratification.

Ratified this 3d day of March, A. D. 1921.

In closing, I wish to call attention to the meeting of the National Drainage Congress, which will be held at St. Paul, Minnesota, September 22 to 24, and your Secretary would suggest that an attempt be made to make an exhibit at this Congress of what North Carolina has accomplished in reclamation work, and to show by photographs, maps, etc., the character of the land, what it will produce, and its relation to markets. It is believed that this is a splendid opportunity for advertising our reclaimed lands.

REPORT OF THE TREASURER

The report of the Treasurer, Joseph Hyde Pratt, was submitted, as follows, and referred to the Auditing Committee, who audited and approved the report:

FINANCIAL STATEMENT OF THE NORTH CAROLINA DRAINAGE ASSOCIATION

MARCH, 1920, TO APRIL, 1921

CR.		
Balance on hand March, 1920		$ 4.42
Received from memberships		182.00
DR.		
Paid to University Press for printing, April 9, 1920 (No voucher)	$ 10.00	
Paid to R. S. MacRae for postage, April 14, 1920 (Voucher No. 1)	20.00	
Paid to University Press for printing, May 4, 1920 (Voucher No. 2)	7.00	
Paid to National Drainage Journal for 52 subscriptions (Association membership), June 4, 1920 (Voucher No. 3)	78.00	
Paid to University Press for printing, April 1, 1921 (Voucher No. 4)	18.00	
Paid to R. S. MacRae for postage, April 7, 1921 (Voucher No. 5)	40.00	
	$173.00	$186.42
Balance on hand April 9, 1921	$13.42	
	$186.42	$186.42

Approved:

F. O. BARTEL,
W. W. PEIRCE,
Auditing Committee.

APPOINTMENT OF COMMITTEES

The President appointed the following committees:

Resolutions Committee:

C. W. Mengel, *Chairman*, Beaufort County.
H. M. Lynde, Wake County.
R. O. Bagley, Currituck County.
J. L. Becton, New Hanover County.
W. D. Alexander, Mecklenburg County.
R. L. Banks, Jr., Gates County.
W. M. Hinton, Camden County.
Thomas J. Nixon, Perquimans County.
Francis D. Winston, Bertie County.

Nominations and Next Meeting Place:

W. A. McGirt, *Chairman*, New Hanover County.
W. S. Pharr, Mecklenburg County.
B. M. Potter, Craven County.
W. W. Jarvis, Currituck County.
W. W. Peirce, Wayne County.
P. H. Johnson, Beaufort County.

Membership Committee:

R. K. Smith, *Chairman*, Norfolk, Va.
Miss Minnie Queen, Wilkes County.
Dr. Jas. L. Alexander, Mecklenburg County.
R. R. Cotten, Pitt County.
E. D. Winslow, Perquimans County.
W. A. Ellis, Gates County.

Auditing Committee:

F. O. Bartel, Wake County
W. W. Peirce, Wayne County

The chief subject considered at the morning session was farm loans, and this discussion was led by Hon. A. F. Lever, member of the Federal Farm Loan Board. Mr. Lever called attention to the fact that farmers should not remain the victims of speculators and go "broke" every two or three years; that the farmer produces two of the three things absolutely necessary to sustain life and civilization, and can command his own price for his products when once he determines to control those products and takes the control out of the hands of speculators. He also showed how the farmer can control the distribution and sale of his products; how he can secure a return for his labors that will make farm life so profitable and attractive that his children will prefer the farm to the city; and how the farmers of the Nation may pool their resources and finance themselves in any contingency. Mr. Lever's speech is given in full on page 28.

SPECIAL SESSION, 1:30 P. M.

CONFERENCE OF DRAINAGE ENGINEERS

COLONEL JOSEPH HYDE PRATT, Presiding.

At this conference, which was attended by twelve engineers interested in reclamation work in North Carolina, the following questions were discussed:

1. What is a drainage engineer?
2. Status of drainage engineers in North Carolina.
3. Relation of drainage engineer to preliminary examination of drainage district.
4. Should the State assist in making these preliminary surveys?
5. Would stream measurements be of value on certain of the rivers and streams running through these swamp areas?
6. Topographic maps.
7. Appointment of drainage engineers: Request of petitioners, clerk of court, organizer of district.
8. The act passed by the General Assembly of 1921 to regulate the practice of engineering and land surveying.

While the time for discussion of these subjects was limited, many interesting points were brought out by the different engineers, and the conference was considered well worth while.

AFTERNOON SESSION, 2:30 P. M.

HON. JOHN H. SMALL, Presiding.

The afternoon session was opened by an address by Mr. S. H. McCrory, Chief of Drainage Investigations of the United States Department of Agriculture, who spoke on the "Economic Value of Reclaimed Swamp Lands." He stressed one point which had not previously been brought out at meetings of the Association, which was that certain of our reclaimed swamp lands should be maintained in timber rather than cleared off for agricultural purposes. He showed that many thousands of acres of land in Eastern North Carolina were much more adapted for raising timber than for agricultural purposes.

Mr. W. D. Clark, of the Forestry Division of the North Carolina Geological and Economic Survey, followed Mr. McCrory with a paper on "The Relation of Forestry to Drainage." Mr. Clark's paper is given in full on page 33.

Major W. A. Graham, Commissioner of Agriculture, discussed the development and progress of agriculture in North Carolina, and commended highly the work of the North Carolina Drainage Association.

Other speakers of the afternoon session were Judge Francis D. Winston, who made a very enthusiastic talk commending the work of the Association and calling attention to the fertility of the soil of Eastern North Carolina, which needed only to have its surplus water taken off to make it the most productive soil in the country; and Colonel Joseph Hyde Pratt, who spoke particularly of the need of establishment of drainage districts in Pasquotank County, and stated that the North Carolina Geological and Economic Survey would gladly coöperate with landowners in establishing such districts.

EVENING SESSION, 8:00 P. M.

BANQUET AT SOUTHERN HOTEL

The banquet was given Tuesday evening at 8 o'clock by the citizens of Elizabeth City to the North Carolina Drainage Association was carried out under the auspices of the Elizabeth City Chamber of Commerce, of which Mr. Richard C. Job is the efficient secretary.

Mr. W. A. Worth was toastmaster, and very pleasantly and cleverly performed his duties, and in his informal talk calling the banquet to order made everybody feel at home, and from that time until the banquet was over there was a spirit of good fellowship prevailing and a freedom from restraint. For the special entertainment of the guests a double quartet from the Colored State Normal School at Elizabeth City sang old-time negro melodies, which were keenly appreciated by all. There were no long speeches, but the toastmaster called on several for short talks. Among those responding were Congressman John H. Small, Major W. A. Graham, J. M. Ferriss of Norfolk, Judge Francis D. Winston, C. Woodard of Wilson, W. O. Saunders, and Herbert Peele of Elizabeth City, and Colonel Joseph Hyde Pratt. The following is a report of the talks as made by the *Elizabeth City Daily Advance:*

The theme of Mr. Small and Mr. Ferriss was the same: The advantages enjoyed by Eastern North Carolina as compared with other sections of the United States.

"If I were a young man," said Mr. Small, "I would as soon settle in this section and undertake here to carve out my fortune as in any section of the continent—and I have traveled in almost every region of the Union and in many parts of the American continent besides."

Mr. Small also took occasion to congratulate Elizabeth City on its growth and development, on its thriving Chamber of Commerce, on its coöperative community spirit, and to express the appreciation of the Association for the handsome fashion in which Elizabeth City had played host to the convention.

Mr. Ferriss, born in the West, traveled all over the Union, a student of farming conditions wherever he had been, spoke in glowing terms of the advantages of this section in the fertility of its soil, which he said compared favorably with that of the delta of the Nile, in unsurpassed climate with three times the growing season of Minnesota, in its abundant rainfall and in its nearness to the great consuming centers. In these latter respects he compared

it to the prairies, to the more southern states, and to the extreme western states. Some of these, he pointed out, are subject to prolonged droughts which sometimes utterly destroy the crops. Others are subject to disastrous floods which inundate the land and sweep away millions of dollars worth of wealth. None of them can so easily reach the great consuming centers. Our needs, he said, are drainage and transportation.

Colonel Pratt talked of linking up the section with North Carolina by two great highways, one to Wilmington and one to Raleigh, and he believed that such outlets for this section would be in course of construction in the very near future. He said that Elizabeth City's truly remarkable growth and progressive spirit, under the conditions that have prevailed and the handicaps that have been imposed by lack of good roads and of adequate drainage, is an index of what may be expected of this city and section when these handicaps have been removed. He ventured the prediction that the next time the Drainage Convention meets in Elizabeth City many of the delegates from all sections of the State will come by automobile instead of by the Norfolk Southern.

Covers were laid for one hundred guests, and precisely that number were present. From the standpoint of the menu and service the banquet, the first served at the Southern under the present management, was as pronounced a success as in other respects.

WEDNESDAY, APRIL 13, 10 A. M.—Morning Session

HON. JOHN H. SMALL, Presiding.

At the opening of the session the Secretary read the following letter from Mr. Henry C. Wallace, Secretary of Agriculture, and telegram from Mr. Mark W. Potter, Commissioner of the Interstate Commerce Commission:

THE SECRETARY OF AGRICULTURE
WASHINGTON

MARCH 23, 1921.

DEAR MR. PRATT:

I am in receipt of your letter of March 21, and thank you for the invitation to be in Elizabeth City, North Carolina, to attend the annual convention of the North Carolina Drainage Association on April 12 and 13.

In view of other engagements already made, I regret to advise you that I cannot give you a favorable reply. I shall hope, however, to be able to visit your section of the country some time in the near future.

Very truly yours,

(Signed) HENRY C. WALLACE.

MR. JOSEPH HYDE PRATT,
Secretary, North Carolina Drainage Association,
Chapel Hill, North Carolina.

WASHINGTON, D. C., April 11, 1921.

HON. JOHN H. SMALL,
Drainage Conference, Elizabeth City, N. C.

Regret impossible to attend drainage conference. Matters of exceptional importance require my presence here.

(Signed) MARK W. POTTER.

The first speaker was Mr. W. A. McGirt, manager of the North Carolina Landowners' Association, who spoke on "Eastern North Carolina: Its Commercial Development." Mr. McGirt stressed the importance of drainage as an essential in the development of Eastern North Carolina, and urged business men to devote more of their time to the drainage problem and other questions so vital to the future of this section. The speaker stated that he would not hesitate to compel the children of our public schools to study the problems of our Coastal Plain, if he had the power to do so, that these children, after they reach maturity, might understand the handicaps that are retarding our development, and proceed to remove them.

The next speaker was Mr. C. G. Elliott, consulting engineer of Washington, D. C., who was formerly Chief of Drainage Investigations of the United States Department of Agriculture, and has been closely identified with drainage work in North Carolina since its beginning. Mr. Elliott spoke on "Some Features of Drainage and Land Development." His was a very interesting and instructive paper, and is given in full on page 36.

Mr. R. K. Smith of Norfolk, representing the Roper Lumber Company, who have organized several drainage districts in the Albemarle area, made a short but interesting talk on the work of the company and the value of the reclaimed lands and the probability of the area becoming the greatest agricultural section of the South.

The next subject discussed was Tile Drainage. Mr. H. M. Lynde, of the United States Department of Agriculture, led the discussion, and he was followed by D. C. McCotter, of Cash Corner; Mr. A. S. Cline, Assistant Director of the Drainage Experiment Station of the North Carolina Department of Agriculture at Wenona; Mr. L. W. Shook, manager of the Cotton Valley Farm at Tarboro, and Mr. F. P. Latham, owner of the Circle Grove Farm at Belhaven, all of whom made very interesting and instructive talks. Their papers are given in full on pages 42-47.

The last address of the convention was made by Dr. T. H. D. Griffitts of the United States Public Health Service, who spoke on the general subject of Drainage versus Mosquitoes and Malaria. His paper is given in full on page 47.

The convention was then thrown open for consideration of any question which any of the members wished to bring up. In reply to a question regarding drainage in the Piedmont section of the State, Mr. W. D. Alexander, drainage engineer, of Charlotte, N. C., gave a very instructive and interesting résumé of what had been accomplished in Mecklenburg County and the elimination of malaria in the Charlotte district by drainage of the overflowed lands. Mr. Alexander has been connected with a great many of the Piedmont drainage districts, and stated that in all cases the people had been extremely pleased with the results obtained in the reclamation of their overflowed lands.

Mr. H. E. Ownley, of Chapanoke, R. No. 1, raised the question of how to start a drainage district in his section of Pasquotank County. He stated that he believed the people were interested in the reclamation of their swamp lands and were ready to assume the obligation of the cost of the drainage if some one would show them how to proceed and let them know definitely whether the drainage was feasible. In reply to Mr. Ownley, the State Geologist stated that the Survey would coöperate with the people, and Mr. McCrory, in charge of drainage investigations of the United States Department of Agriculture, stated that his department would also assist those people in making a preliminary examination. Mr. Ownley's request for such assistance was carried out and a preliminary report made. This is given on page 65.

Another question raised was how to bring settlers to take up the reclaimed lands. One of the delegates called attention to the fact that there was a vast difference in selling the reclaimed lands and in settling those same lands. It seemed to be the consensus of opinion that there was a large field of work for the Department of Agriculture and the State Survey to assist in advertising these reclaimed lands and call to the attention of those seeking agricultural lands the advantages of fertility, nearness to market, and transportation facilities of these black-soil lands of Eastern North Carolina.

The State Geologist called attention to a communication he had had from Mr. Mark W. Potter of the Interstate Commerce Commission, who is a large landowner in Eastern North Carolina, in regard to describing these lands; that in calling attention to them, instead of speaking of them as "reclaimed swamp lands," we ought to give them a name that indicates what they are, and suggested "the black-soil lands of Eastern North Carolina."

At the suggestion of the President, the convention decided to continue the morning session through the noon hour and until all business of the convention had been completed.

The President then called for the reports of the several committees.

The report of the Committee on Resolutions was read by Mr. C. W. Mengel, chairman, and was as follows:

REPORT OF THE COMMITTEE ON RESOLUTIONS

The North Carolina Drainage Association, assembled in this the Eleventh Annual Convention, may view with a pardonable pride its records of achievement during the past fifteen years.

North Carolina's activities in drainage are known far and wide, and the rich soils made available by drainage are in demand far beyond the confines of the State. In spite of this progress, however, some older cultivated sections are lagging behind in this movement, and upon these we urge the necessity of falling in line and reaping the sure reward to be gained through drainage.

Since this Drainage Association may be well called the pioneer in a series of progressive moves in our State which culminated in acts of the past Legislature: Therefore, be it

Resolved, That this Association extend its congratulations to the Governor of North Carolina and to the members of the General Assembly of 1921 for the liberal contribution to the progress of the State embodied in the passage of appropriations for good roads, education, health, welfare, and agriculture. The unanimity of action in matters of such broad interior argues well for the State's future progress.

Resolved, That the thanks of this Association are tendered to the officers of the Association for the planning of this most excellent program, and to the speakers who have offered such instructive suggestions and advice.

Resolved, That this Association commend the coöperative work being done by the Drainage Division of the Bureau of Public Roads, U. S. Department of Agriculture, and the North Carolina Department of Agriculture. The pioneer work being done in the tile drainage field and in terracing is worthy of highest praise.

Resolved, That this Association does hereby tender its thanks to Mr. C. G. Elliott, not only for his presence and constructive address at this meeting, but also for past valuable assistance rendered the cause of drainage in this State and the Nation.

Resolved, That we urge upon the next General Assembly the necessity of providing the North Carolina Geological and Economic Survey with funds to carry on investigations and distribute data obtained in stream flow throughout the State. This information is badly needed by the drainage engineers of the State.

Resolved, That this Association urge upon drainage engineers the necessity of recording for future use all data collected for drainage districts, and that such data be recorded with the Geological and Economic Survey so as to link with other surveys in the State, thus aiding in the enormous task of finally completing a topographic map of this State.

Resolved, That the thanks of the Association are tendered the Chamber of Commerce and the citizens of Elizabeth City for their cordial reception and genial hospitality offered and for the splendid arrangements made for the accommodation of the delegates during their stay here, and to the newspapers for their hearty coöperation in advertising and reporting the convention.

Resolved, That the thanks of the Association be tendered its President, Hon. John H. Small, not only for his abiding interest in drainage but also for his continued devotion to all matters relating to the welfare of the citizens of the State.

Resolved, That this Association offer felicitations to its Secretary, Colonel Joseph Hyde Pratt, in his first appearance before it in a number of years. It is our wish that we may long have available his splendid counsel and assistance.

Respectfully submitted,

C. W. MENGEL, *Chairman*;
H. M. LYNDE,
R. O. BAGLEY,
J. L. BECTON,
W. D. ALEXANDER,
T. J. NIXON,
W. M. HINTON,
R. L. BANKS, JR.

The report of the committee was approved and, on motion being made and seconded, the resolutions were adopted as read.

The convention unanimously extended a vote of thanks to Mr. C. G. Elliott for his thoughtful and carefully prepared paper.

REPORT OF COMMITTEE ON NOMINATIONS AND NEXT MEETING PLACE.

The report of the Committee on Nominations and Next Meeting Place was read by Mr. W. A. McGirt, as follows:

Nominations:

For President, HON. JOHN H. SMALL, Washington.
For First Vice-President, J. E. SHEPARDSON, Belhaven.
For Second Vice-President, H. M. LYNDE, West Raleigh.
For Secretary-Treasurer, JOSEPH HYDE PRATT, Chapel Hill.

Members of the Executive Committee:

HON. JOHN H. SMALL, *ex-officio*, Chairman;
C. W. MENGEL, Beaufort;
W. D. ALEXANDER, Mecklenburg;
B. M. POTTER, Craven;
W. W. PEIRCE, Wayne;
P. H. JOHNSON, Beaufort;
I. C. HENDERSON, Onslow;
R. L. BANKS, JR., Gates;
R. O. BAGLEY, Currituck;
WALTER L. COHOON, Pasquotank.

The report of the committee was accepted and, on motion duly made and passed, the Secretary was instructed to cast a ballot for the nominees as submitted by the committee. The Secretary cast the ballot and declared the nominees elected.

Next Meeting Place: The following telegram from Goldsboro was read by Mr. McGirt:

GOLDSBORO, N. C., April 12, 1921.

President Drainage Convention, Elizabeth City, N. C.:

We extend to you a most hearty invitation to hold your next annual convention in our city. We assure you that if you meet in Goldsboro we shall do all in our power to make your organization successful. Goldsboro, as you know, is a railroad center and can be reached conveniently from every section of the State.

Yours for service,
(Signed) THE GOLDSBORO CHAMBER OF COMMERCE,
W. C. DENMARK, *Secretary.*

8:27 A.M., April 13.

After reading the telegram, Mr. McGirt reported that the committee recommended unanimously that the next convention of the North Carolina Drainage Association be held at Goldsboro, Wayne County. Before taking action on the recommendation of the committee, Major W. W. Peirce of Goldsboro made an impressive talk regarding the advantages of Goldsboro for holding the convention and urged the convention to adopt the committee's recommendation.

On motion duly made and seconded, the convention unanimously adopted the committee's report and selected Goldsboro as the next meeting place of the convention.

REPORT OF MEMBERSHIP COMMITTEE.

The report of the Membership Committee was read by the chairman, Dr. J. L. Alexander, as follows:

It is the sense of the Committee that, in the interest of an increased membership in the Association, the dues be reduced to one dollar ($1.00) per year for membership fee, so that all may join.

Respectfully submitted,

J. L. ALEXANDER, *Chairman;*
R. K. SMITH,
R. R. COTTEN,
E. D. WINSLOW,
W. A. ELLIS,
MISS MINNIE QUEEN,
Membership Committee.

Upon motion duly made and seconded, the report of the committee was unanimously adopted.

The convention adjourned *sine die* at 2 p. m.

The delegates remaining over in Elizabeth City, Wednesday afternoon, were given an automobile ride to Weeksville over some of the good roads of Pasquotank County. Those furnishing automobiles for the delegates were: J. T. McCabe, W. J. Woodley, Camden Blades, Dr. A. L. Pendleton, M. W. Ferebee, C. O. Robinson, and C. A. Cooke. A score of other automobiles were offered, and Secretary Job, if he had asked for them, could have had every automobile in the city not used strictly for business.

DELEGATES REGISTERED AT ELEVENTH ANNUAL CONVENTION NORTH CAROLINA DRAINAGE ASSOCIATION, ELIZABETH CITY, APRIL 12 AND 13, 1921.

Beaufort County:

- Dodd, J. G. .... Belhaven, N. C.
- Johnson, P. H., Pantego Drainage District .... Pantego, N. C.
- Latham, F. P. .... Belhaven, N. C.
- Mengel, C. W., Drainage Engineer .... Belhaven, N. C.
- Small, John H. .... Washington, N. C.
- Wilkinson, J. A. .... Belhaven, N. C.

Bertie County:

- Evans, J. C. .... Windsor, N. C.
- Winston, Judge Francis D. .... Windsor, N. C.

Brunswick County:

- Babson, M. F. .... Ash, N. C.

Camden County:

- Burgess, H. B. .... Old Trap, N. C.
- Burgess, J. M. .... Old Trap, N. C.
- Cuthrell, F. C. .... Camden, N. C.
- Hinton, W. M. .... Shiloh, N. C.
- Toxey, M. N. .... Shiloh, N. C.

Chowan County:

- Griffin, E. J. .... Edenton, N. C.

Craven County:

- Potter, B. M., Drainage Engineer .... New Bern, N. C.

Currituck County:

- Bagley, R. O. .... Moyock, N. C.
- Cox, D. A. .... Moyock, N. C.
- Graves, W. G. .... Moyock, N. C.
- Jarvis, W. W. .... Moyock, N. C.
- Tate, W. J. .... Moyock, N. C.

Gates County:

- Banks, B. L., Jr. .... Gatesville, N. C.
- Blanchard, Rufus .... Trotville, N. C.
- Derby, W. B. .... Gates, N. C.
- Ellis, W. A. .... Gatesville, N. C.
- Willey, J. F. .... Gates, N. C.

Hyde County:

- Clayton, John M. .... Engelhard, N. C.
- Gibbs, Theodore .... Scranton, N. C.

Mecklenburg County:

Alexander, Dr. Jas. R., Mecklenburg Drainage Comr. .... Charlotte, N. C.
Alexander, W. D., Drainage Engineer .... Charlotte, N. C.
Knox, J. M., Drainage Commissioner .... Huntersville, N. C.
Pharr, W. S., Drainage Commissioner .... Charlotte, N. C.
Wolfe, C. H., Jr., Drainage Commissioner .... Charlotte, N. C.

New Hanover County:

Becton, J. L., Drainage Engineer .... Wilmington, N. C.
McGirt, W. A., Mgr. N. C. Landowners Association .... Wilmington, N. C.
Sprecken, F. von, Drainage Engineer .... Wilmington, N. C.

Onslow County:

Henderson, F. C. .... Maysville, N. C.

Orange County:

Pratt, Jos. Hyde, State Geologist .... Chapel Hill, N. C.
Clark, W. D., Chief Forest Fire Warden .... Chapel Hill, N. C.

Pamlico County:

Cowley, H. .... Cash Corner, N. C.

Pasquotank County:

Bell, C. D. .... Elizabeth City, N. C.
Boettcher, Mrs. Sallie .... Elizabeth City, N. C.
Brite, E. C. .... R. F. D. No. 6, Elizabeth City, N. C.
Brite, J. R. .... Elizabeth City, N. C.
Brock, C. H. .... Elizabeth City, N. C.
Brothers, F. W. .... Elizabeth City, N. C.
Brothers, W. W. .... Elizabeth City, N. C.
Carver, Harry L. .... Elizabeth City, N. C.
Chappell, R. O. .... Elizabeth City, N. C.
Clarke, Geo. W. .... Elizabeth City, N. C.
Cohoon, Walter L. .... Elizabeth City, N. C.
Cooke, C. A. .... Elizabeth City, N. C.
Crawley, Capt. R. T. .... Elizabeth City, N. C.
Falls, G. W. .... Elizabeth City, N. C.
Foreman, J. W. .... Elizabeth City, N. C.
Foster, W. A. .... Elizabeth City, N. C.
Gaither, Chas. W. .... Elizabeth City, N. C.
Gaither, W. G. .... Elizabeth City, N. C.
Granger, E. D. .... Newland, N. C.
Gregory, W. J. .... Elizabeth City, N. C.
Hall, John H. .... Elizabeth City, N. C.
Hinton, W. M. .... Elizabeth City, N. C.
Hite, Capt. M. P. .... Elizabeth City, N. C.
Jennings, A. J. .... Elizabeth City, N. C.
Lowry, F. W. .... Elizabeth City, N. C.

Pasquotank County—continued.

Meads, A. A. .... Weeksville, N. C.
Moran, J. Sterling .... Elizabeth City, N. C.
Neal, A. S. .... Elizabeth City, N. C.
Ormand, Rev. J. M. .... Elizabeth City, N. C.
Ownley, H. E. .... R. F. D. No. 1, Chapanoke, N. C.
Ownley, T. S. .... Chapanoke, N. C.
Perry, J. W. .... Okisco, N. C.
Pritchard, W. F. .... Elizabeth City, N. C.
Saunders, W. O. .... Elizabeth City, N. C.
Sawyer, D. E. .... R. F. D. No. 4, Elizabeth City, N. C.
Scott, S. W. .... Weeksville, N. C.
Seeley, Harry M. .... Elizabeth City, N. C.
Sharber, J. G. .... Elizabeth City, N. C.
Sharber, W. D. .... Elizabeth City, N. C.
Simpson, J. F. .... Chapanoke, N. C.
Spence, B. F. .... Elizabeth City, N. C.
Temple, D. C. .... Elizabeth City, N. C.
Toxey, A. F. .... Elizabeth City, N. C.
Twiford, D. C. .... Elizabeth City, N. C.
Wilkins, J. H. .... Elizabeth City, N. C.
Williams, J. N. .... Elizabeth City, N. C.
Williams, Jno. T. .... Elizabeth City, N. C.
Williams, W. J. .... Elizabeth City, N. C.
Wood, J. Q. A. .... Elizabeth City, N. C.
Woodley, W. J. .... Elizabeth City, N. C.

Perquimans County:

Cox, David .... Hertford, N. C.
Nixon, Thos. J., Jr. .... Hertford, N. C.
White, W. E. .... Hertford, N. C.
Winslow, E. D. .... Hertford, N. C.
Winslow, T. F. .... Hertford, N. C.

Pitt County:

Cotten, R. R. .... Bruce, N. C.

Tyrrell County:

Swain, Hon. H. L. .... Columbia, N. C.

Wake County:

Andrews, Melvin, with *Progressive Farmer* .... Raleigh, N. C.
Bartel, F. O., Drainage Engr., N. C. Dept. of Agriculture .... Raleigh, N. C.
Graham, W. A., Commissioner of Agriculture .... Raleigh, N. C.
Joyner, Andrew .... Raleigh, N. C.
Lynde, H. M., Drainage Engineer .... Raleigh, N. C.
Welch, Wm. J., with *Progressive Farmer* .... Raleigh, N. C.

Washington County:

Cline, A. S. .... Wenona, N. C.
Martin, Van B. .... Plymouth, N. C.
Temple, N. M. .... Wenona, N. C.

Wayne County:

Peirce, Wentworth W. .... Goldsboro, N. C.

Wilkes County:

Queen, Miss Minnie .... North Wilkesboro, N. C.

Wilson County:

Woodard, C. .... Wilson, N. C.

Out-of-State Delegates:

Thompson, M. W., Thompson & Mosley, Inc. .... Atlanta, Ga.
Severn, B. D. .... Atlantic City, N. J.
Ferriss, J. M. .... Norfolk, Va.
Griffitts, Dr. T. H. D., U. S. Public Health Service .... Norfolk, Va.
McKinney, F. W. .... Norfolk, Va.
Portlock, F. L. .... South Norfolk, Va.
Smith, R. K., Norfolk Southern Land Company .... Norfolk, Va.
Widgeon, J. M. .... Norfolk, Va.
Wright, T. J., Jr. .... Norfolk, Va.
Parker, J. V. .... Portsmouth, Va.
Fuller, Frank L. .... Richmond, Va.
Elliott, C. G. .... Washington, D. C.
McCrory, S. H., U. S. Department of Agriculture .... Washington, D. C.

PAPERS DELIVERED AT THE ELEVENTH ANNUAL DRAINAGE CONVENTION.

FARM LOANS

By HON. A. F. LEVER, Member Federal Farm Loan Board

The question uppermost in the minds of farmers is what has happened to bring about the present situation with respect to the value of farm products; what has occurred to justify a slump in prices of farm products ranging from 50 per cent to 100 per cent within a period of twelve months. Certainly there are no less mouths to be fed now, or bodies to be clothed now, than there were twelve months ago. The yield of farm products for the year 1920 was not unusually large. The need for such products has undoubtedly kept pace with the supply of them. This being true, the inquiry as to the cause for the slump in prices of farm products becomes all the more important and interesting.

THE DEMAND FOR FARM PRODUCTS NEVER GREATER THAN NOW

There are tens of thousands of men, women and children throughout the world who are on the veritable verge of starvation and who are moving from place to place clothed in rags. There are more of this unfortunate class of people now than there were a year ago, which would suggest to the student of economy that the value of things to eat and with which to clothe the body should be higher than in 1920; and to find the reverse of it, presents a line of study which must develop the discovery of certain broad principles which govern in the determination of prices.

PLENTY OF DEMAND BUT LACK OF MONEY OR CREDIT.

The very first thing that we come in contact with in the study of the problem is the fact that there is an unusual demand for farm products throughout the world but there is a lack both of money and credit with which to make good the demand. The starving children of Armenia need your wheat and corn and livestock, but they have nothing with which to pay you for it. The cotton factories of France, Germany, Austria, and Russia could, if put into operation, make heavy inroads into the six million bales of surplus cotton now held in the South, but the difficulty here again is that the market of Germany, Austria, and Russia are closed to the cotton producer, while the difference in exchange rates makes it almost impossible for the factories of France to buy the raw material, manufacture and sell it in competition with American manufacturers and make a profit.

The domestic consumer of farm products is on a buyer's strike. He is refusing to buy at the exhorbitant prices demanded by some retailers, except as he must buy to meet immediate needs. This, of course, results in a lessened domestic demand which reflects itself in prices.

The domestic manufacturer, the wholesaler and the jobber, because of the uncertainty of the price of the raw material and the demand for the finished product, are, as it were, dancing the hesitation dance, and they too are in the market only to fill immediate demands.

RESTORATION OF CONFIDENCE.

The problems and difficulties of agriculture at this moment are fundamental in character. They cannot be solved by the application to them of expedience or nostrums. The trouble is deep seated and requires a major operation. It

cannot be cured by the application of poultices and salves. The knife of the surgeon is necessary. The patient is mighty sick but he is more frightened than sick, and before we can hope to get him in a position to apply the remedy which will cure him, we must first convince him that he is not nearly so sick as he is scared. In these critical times there is no place for the pessimist. This great country of ours is not headed in the direction of the "dimnition of bow-wows." A nation which can mobilize within two years thirty billions of wealth, arm and equip five millions of boys and send two millions of these across the water to fight on foreign shores is not going to fail to arise to this emergency and to meet it and overcome it. The one big immediate need of this hour is the restoration of confidence in all classes of people in the future of our country, coupled with a resolution that we are going to think and act in the light of the sun and not in the gloom of the darkness. The situation may be likened to a flock of wild geese that has been disturbed unexpectedly by the hunter. They are flying pell mell in every direction, each individual looking out for itself. But this will not continue long because pretty soon you will see the flock lining out in proper formation under the leadership of one who knows his business and destination. We need only some leadership, some stepping out as it were, in the direction of a return to normal, in order that the whole flock of us may begin to set ourselves in the same direction. And when this happens, manufacturing will begin, the jobber and the wholesaler will set their machinery in motion, retailers will take on new courage and hope, and all of these things will reflect themselves in a better agricultural situation. In the meantime, it is to be hoped that foreign markets will begin to right themselves with the aid of credit corporations formed in this country under the provisions of the Edge Act and with the help of the recently restored War Finance Corporation.

OUT OF THE GLOOM—LEARNED WHOLESOME LESSONS.

But from the viewpoint of agriculture the mere restoration of confidence is not going to furnish a permanent solution of its problems. There are difficulties that require for their remedying the concerted action of the states and the nation as well as the farmers themselves.

THE FACTS.

When it is demonstrated by the fact that the country teacher, the country preacher, and the farmer receive the lowest scale of wages of any class of our population, it must be admitted that there is something fundamentally weak in the system under which agriculture is operating. The existing system has not only eventuated in the fact just mentioned, but it is responsible for the fact—

(a) That, more than one-third of our farm population is tenant. This means absentee landlordism, or to express it more accurately, inefficient farming and unwholesome rural conditions.

(b) That, not over twenty per cent of our farm homes have in them either running water—the burden lifter of the housewife—or artificial lights; the average daily labor of the average farm woman is from twelve to thirteen hours.

The isolated life of the average farm woman presents the amazing and indefensible tragedy of American life. The farm woman is the crux of the rural problem. When she is happy and contented with her surroundings, you will find her boys and girls likewise to be happy and contented, but it is the revolt of these boys and girls against the life of drudgery which their parents lead that has resulted in the increasing drift of the population from country to town, resulting, as disclosed by the present census for the first

time in our history, in there being a larger per cent of people in towns and cities than there are in the country. It may sound ridiculous, and by the unthinking be called foolish, to venture the assertion that Henry Ford in supplying the world with a cheap, quick method of transportation, is exerting upon rural life a more profound influence than has ever been exerted upon it by any man living or dead.

(c) That, the farmer is without effective voice in the determining of the price of his products.

(d) That, as a result of this condition, the average farmer of Missouri will not realize from his 1920 crop more than sufficient to pay his taxes and the interest upon his capital investment.

WHAT CAUSES HAVE LED TO SUCH A SITUATION?

What have been the underlying causes resulting in such an unwholesome condition?

(a) The farmer has been taught to walk the furrow and produce, and per capita he is the best producer in the world. We have taught him to become an expert with his hands and have left him as a child in the use of his head in the management of his affairs other than production.

(b) The farmer has never regarded himself, nor have the people, anything but a producer. He is more than that. He is a manufacturer, and a merchant as well. It would not be wise, in my judgment, for him to undertake in himself to become a merchant. Of course, he cannot escape being a manufacturer. It is wise, however, not only wise but absolutely essential, to his prosperity that he should organize commodity sales agencies with expert salesmen to do the selling for him and this should take into account both domestic and foreign business.

(c) For the great staple crops like wheat, corn, cotton, wool, and livestock, there is no existing machinery for the orderly marketing of farm products.

(d) Agriculture is both under-capitalized and is without any adequate system of credits adapted to its peculiar needs.

THE SYSTEM RESULTS IN—

(a) The terrific strain upon the finances of the country at the crop moving season.

(b) An inefficient and expensive system of transportation.

(c) An uneconomic and unwise strain upon the buying and absorptive powers of the purchasers of farm products. Under this system we are asking the buyers of farm products to meet their needs for a period of twelve months in a period of from four to five months, with the inevitable result to the seller of these products.

(d) The system forces the farmer to sell in four or five months of the year from seventy-five to eighty per cent of that which it has taken him twelve months to prepare for—seed, cultivate and prepare for market, with the resultant autumnal dip in the price of farm products.

THE COSTS OF INEFFICIENCY OF SYSTEM ALWAYS CHARGED AGAINST THE FARMER.

It must be understood in this discussion that all costs anywhere along the line, chargeable to the inefficient system under which the farmer operates, are always chargeable against the farmer. If there are expensive methods of transportation of farm products from farm to market, the expense falls upon the farmer's product; if railroad rates are high or if railroad facilities are inadequate to meet the autumnal crop movement, with the result that wheat and corn lie rotting on the side tracks, these expenses are charged

against the farmer; if oceanic rates are high because of any inefficiency of the system, the difference between such rates and rates under an efficient system is charged against the price of the farmer's products. If there is any lack of credit facilities which if existing would enable the farmers not only to produce less expensively but to sell more intelligently and at a larger profit, here again the difference is chargeable to the farmer.

The matters which we have just discussed are not of a temporary character. They are permanent, inherent, and fundamental, and nothing save fundamental remedies will reach them. The remedies which suggest themselves to me are:

(a) The elimination of all unnecessary factors in the present system of distribution.

(b) The organization of commodity sales agencies.

(c) The standardization of farm products into grades and classes.

(d) The warehousing of sufficient quantities of products to set up an even flow of such products into the market of the world as the immediate demands of the world call for them.

(e) The devising of such credit machinery as will enable the farmer to market his products in a sane and orderly way.

THE LAST THE MOST IMPORTANT CONSIDERATION.

In the study of any phase of agriculture at any point in its varied processes from cheaper and greater production to the installation of a real system of marketing, the student is always in the final analysis confronted with the problem of providing the necessary funds with which to do the necessary things sought to be done. You can't pay better salaries to preachers and teachers; you can't have better school houses and churches; you can't build warehouses and elevators; you can't provide improved machinery and improved livestock; nor can you install lights, and running water, or Ford automobiles, or carpets and pictures for the farm home; nor can you pay your debts and market your products over a period of twelve months instead of four, unless you have money with which to do it, and this presents, therefore, the all important problem of agriculture at this time. All others are insignificant in comparative importance.

THE APPLICATION OF AN OLD LAW WILL DO IT.

The existing banking system of this country has been built up to meet the especial need of commerce.

The turn over of the capital investment of the average merchant is once in sixty or ninety days and hence you have the sixty-day paper of the Federal Reserve Act. The banker, through long years of training, thinks in the psychology of a quickly maturing paper, not only this, but he would not be either safe or a successful banker if he did not think in such terms. Banking assets to be profitable must have a rapid and constant turn over.

The turn over of the capital investment of the farmer is once in 365 days, and for some unaccountable reason his debts have been made to fall due at about the same time each year and only once a year. A paper, therefore, with a maturity of only sixty or ninety days, certainly, in times of financial stress when money is hard to get, is of little value to him. If we are to solve this credit problem, we must provide him with a paper which has a maturity period equal to the turn over period of his investment, and a paper of less time than nine or twelve months maturity, better fifteen months, cannot be of the greatest value to him.

To my mind a system can be devised which will meet this necessity and it must rest for its success on an old law of economy which has been used

time out of mind by every great business concern to finance itself. This law is predicated upon the pooling of the assets of the concern and the issuance against such pooled assets certificates of indebtedness or debentures in varying denominations and periods of maturity. What is a railroad bond? It is the outstanding evidence, and promise to pay, of the fact that the railroad company has pooled its various assets—its engines, its work tools, its rolling stock, its right of way, into the hands of a trustee, and over which has been placed a blanket mortgage, and that all of these assets are good for the redemption of any of these obligations. What is a government bond? A government bond is the evidence of the fact that Congress under the Constitution has the power to tax all of the assets of all the people to make good the face of the bond. The most striking illustration, however, at what we are aiming at is to be found in the operation of the farm loan system.

A piece of farm land in itself, no matter how valuable, will fail to unlock the doors of credit. A farm mortgage on the same piece of land in itself would have no standing in the money markets of the world, but when under the farm loan act we have set up 4,000 associations of farmers throughout every agricultural county in the United States, and when these associations have taken in many farm mortgages—in the neighborhood of 126,000—and have placed these in Federal Land Banks—regional banks—in the hands of a government appointee known as a farm loan registrar, and these banks have issued against this mortgage farm loan bonds, the Missouri farm has become through this magic a liquid asset which flows freely in the money markets of the country. Under this system within three years of actual operation we have loaned approximately $440,000,000 at interest rates of from 5 to 5½ per cent, and upon the amortization theory of repayment of principal. What is a farm loan bond? It is evidence that a trustee has in his possession farm mortgages which if foreclosed would be sufficient in value to meet the obligations of the bond.

THREE THINGS THE HUMAN FAMILY MUST HAVE.

There are just three things, food, clothing, and fuel, that are necessary to sustain life and civilization, and two of these it will be noted are the products of the farm. It would seem to me that what the human family must have should be susceptible of being made the basis of credit. We can get along somehow without the engine on the B. & O., but we can't get along without biscuits. We cannot safely undertake to convert one of the B. & O.'s shovels into a shirt or one of its picks into a pair of breeches, but we have got to have Southern cotton and Western wool, and that can be made the basis of credit if we shall but apply to them the well known principle of pooling them and issuing against them debentures. The country should be provided first of all with adequate warehousing and elevator facilities. The warehouseable products of the farm should be warehoused and against them should be issued warehouse receipts by commodities, and these warehouse receipts should be pooled in the hands of a government trustee, regionally, and against these there should be certificates of indebtedness with varied maturing periods issued and offered for sale upon the money markets of the country, just as are the bonds of the government and industrial establishments. It may be necessary, in order to give these certificates prestige, to have back of them as an initial capital a revolving fund of sufficient size appropriated out of the treasury. But any scheme of this kind should look ultimately to providing its own capital and retiring the government capital so that the system would be purely a farmers' system, operated under government supervision and regulation, as is the farm loan system. Such certificates would undoubtedly command a ready sale at a reasonable rate of interest, and from the sale of such certificates the farmer would derive

the money with which to do the things that are necessary to make country life worth while. Already in the states of Washington and Idaho a plan almost identical to the one here suggested is in actual successful operation, but it is my thought that for these certificates to sell at the lowest rate of interest it would be wiser to regionalize rather than localize the system.

THIS DEPENDS ON ORGANIZATION.

The working out of this system of farm credit, as well as the solution of all the other problems of agriculture, depends upon organization of the farmers themselves under sane, conservative, fundamentally sound leadership. Without this, all these efforts will fail. With it there can be but success.

FORESTRY IN RELATION TO LAND DRAINAGE.

BY W. DARROW CLARK, Chief Forest Fire Warden, Forestry Division, North Carolina Geological and Economic Survey

The forestry work of the State is under the Forestry Division of the North Carolina Geological and Economic Survey, of which, as most of you probably know, Colonel Joseph Hyde Pratt is director. In assigning to me my topic, Colonel Pratt also authorized me to treat it with as broad a latitude as I wished. I will therefore emphasize at the outset the direct relations between forestry and drainage, and then touch upon certain aspects of forestry which concern everybody.

The digging of trenches through wet lands for the purpose of lowering the water table has been practiced for ages by those interested in the production of agricultural and horticultural crops; but in North Carolina this practice has developed the fact that the lowering of the water table by trenching where it is too high is as beneficial to forest tree growth as it is to the growth of other crops. Owners of extensive cut over swamp lands have discovered that the increased rate of growth of pine and other forest tree species is sufficiently great after trenching to justify the cost entailed. Thus, even in the event that all our swamp land area may not be needed in the immediate future for agricultural development, still its drainage may be justified by its effect in stimulating tree growth as well as by its beneficial effects upon general health conditions.

Every man, woman, and child in America is vitally concerned in the perpetuation of our forests. It is obvious that a great many do not realize it and for this reason the problem of perpetuation is made increasingly difficult.

To bring the great mass of our people to a very clear and definite realization of their dependence on proper forestation falls as a duty upon those who can visualize what the situation in the country will be unless greater efforts are exerted to reforest the vast areas of nonagricultural and cut over land, and to stop the enormous annual destruction by fire of young forest growth as well as mature timber.

Many of our strongest advocates of forest conservation now realize that a great deal of the propaganda of the past which was designed to promote forest perpetuation has tended toward a crystalization of public sentiment antagonistic to one of our greatest national industries but has accomplished little or nothing towards actually increasing forest production. Such agitation has also signally failed to stop the forest fires which annually destroy millions of acres of promising young forest growth and mature timber at a rate which exceeds annual utilization for constructive purposes.

Lumbermen do not create the enormous demand for their wares. This demand originates in the God given impulse within mankind for progress and development. The lumberman has been the instrument through which the demand has been supplied. He has been the expert in the conversion of trees into lumber shapes for building the homes, factories, stores and warehouses which fill our land; for the construction of railroads and ships, bridges and docks to transport all necessary supplies and to distribute to their various markets the produce of farm and factory.

He has succeeded most in the lumber industry who has been able to supply best and at lowest cost what the consuming public has demanded. Keen competition and hazardous risks of large investments has threatened him with financial ruin and many there have been who failed. Mere self-preservation has been the restraining force keeping the woods operator from conducting selection cuttings, from leaving seed trees, from providing adequate protection against forest fires and from carrying on all other methods advocated for the public interest and for future generations.

Any claim that the lumbermen as a class are less interested in the general welfare and prosperity of this country than any other class is surely without foundation in fact. Not only that, but his mere selfish instinct, of which he probably has about as much as any normal man, certainly would tell him that the demand for his goods would bear a direct relation to general prosperity.

The amazing development of the American industry which we have feared at times to be outstripping our natural forest resources has developed quite independent of human control just as other industrial, economic or physical forces develop independent of human control and often in spite of attempted human control. The Sherman anti-trust law was verbally directed at combinations in restraint of trade. It has been used by a governmental department to threaten lumbermen against curtailing output in order to control prices. At the same time another governmental department is advocating conservative cutting, the leaving of seed trees and other reserves, close utilization of inferior materials, all of which necessitates scattered logging and increased costs all along the line. This could only have been done at a loss unless the lumberman could increase his selling price in proportion to the increased costs which the other governmental department threatened him not to do. Our broad gauged operators have been willing to carry out constructive policies looking toward forest renewal if they could only cover the costs involved. But they could not compete in a free-for-all market where shortsighted operators would sell at a price allowing only a narrow margin over costs of cheap, destructive and wasteful methods of logging and manufacture. In many instances increasing taxes on standing timber has forced hasty exploitation. An annual tax on growing timber is as unfair and unwise as a weekly tax on growing cotton, corn, tobacco, or any other annual crop. Timber is not an annual crop, but more nearly a century crop. All taxes on growing timber should be deferred until the timber is cut. In the meantime a nominal tax on the bare land value should be levied.

Our country is what it is because of the very liberal use which has been made of the wonderful natural resources with which it was endowed. But this in no way excuses or justifies wanton waste or disregard for future supplies of such resources as are renewable.

Without question our people are beginning to realize now that more should have been done to establish new forests when the old ones were utilized and most especially have we all been negligent for our inefficient action in the manner by which we either have attempted or not attempted to stop the rapacious slaughter of forest growth, both young and old, by fire. But both forest production and forest protection are too long an undertaking and too

broad and complicated by too many factors difficult of control for any one class of individuals, or any one class of industries, to handle it successfully.

The active and intelligent support of all the people is just as essential in this task as it is in the task of stamping out disease, crime, vice, extravagance, or any other form of immorality, and until we begin to work on that basis we are doomed to failure.

Before we can accomplish this great task which our continuous prosperity and welfare most surely demand, the new spirit of universal coöperation must wholly supplant the old spirit of antagonism, of passing the buck, of blaming this industry or that industry, or this class or that class.

This can and must be done!

It is hardly possible that any very large percentage of our people can be made to thoroughly understand all the whys and wherefores, all the complex details and all the tactics of accomplishment any more than that they should all thoroughly understand military tactics in order to wage a successful war. But the winning of their moral support is absolutely essential in both undertakings and for this reason an educational campaign must be conducted on a wide scale. The schools, the press, the lecture platform, the pulpit and moving picture houses can all do very effective work in such an educational campaign.

Our local conditions, climatic and physical, as well as human, are so very different that we should never undertake too much standardization. Local experts should have ample authority and means in the choice of methods by which local forest protection and local forest renewal is sought. Local forest laboratories and experiment stations must be established for ascertaining the facts in regard to growth, reproduction, and susceptibility to damage by fire of our different tree species as well as to demonstrate their applicability for various uses. The naval stores industry which formerly was of so great prominence and profits in this coastal country can be restored by the application of intensive methods. In a former publication of our office Colonel Pratt points out how France introduced a lucrative naval stores industry in a land of fever ridden swamps and barren sandhills. North Carolina will not have to introduce the naval stores industry; it is only necessary to direct and assist a natural restoration. Provide seed trees, fire protection, and protection against hogs, and the longleaf pine reëstablishes itself and makes rapid growth.

The lumbermen, I am convinced, can be and may be relied upon to be very instrumental in the development of an efficient plan and organization for handling this problem on a broad scale, and they will guide and direct in establishing safe and sane state and national forest policies. They have built their rail and tram roads, their flumes, sled roads, and pull boat systems into the wild and inaccessible places from our loftiest mountain tops to the lowest swamps. They have bridged canyons and hurled steel cables from spar to spar and made the huge logs yield to indomitable force. By the amazing application of powerful and wonderfully designed machinery they have gathered the raw products of the forests, converted them into usable shapes and distributed them to our local markets for the further fabrication by carpenters, builders, and all manufacturers of wooden articles. They have dredged and drained the inundated swamps and made them produce corn to the tune of 40 to 50 bushels per acre without the turning of a furrow or application of a bit of fertilizer. Their spirit of adventure, their courage, their hardihood, their hazardous risk of large capital, their able management and skill have never been exceeded in any line of endeavor by any race of men. The countries of the world have sent their agents to them for instruction in methods of harvesting forest crops. But as a prophet is not without honor save in his own country, so the American lumberman has been reviled

as the wicked lumberman, as the despoiler of virgin forests, and nature's beauty spots.

A little sober thought should convince us that our economic and industrial system for which we all bear our due share of responsibility, has been the cause of all the damage that has been done, and I have no desire to minimize or belittle that harm. Let the average American have the truth and we may rest assured that he is manlike enough and courageous and just enough to put the blame where the blame rightly belongs, and to grant honor where honor is due. The unnamed captains of our great American lumber industry have shoulders that are broad and backs that are strong. They will take up their full share of the burden of restoring the forests. They know the woods, they have the practical experience, they have the organizing ability, they have the vision and the will, but they simply cannot do it all. Give them but the necessary wholehearted confidential support and I feel convinced that they will accomplish in a most creditable manner both adequate fire control and adequate reforestation.

The carrying out of a program adequate to meet the needs of the situation will call for the expenditure of sums in proportion to the magnitude of the task. As the matter of size of cost becomes of less moment, the manner of distribution of cost becomes one of greatest importance.

From each according to his ability, should be the personal impulse and equity as between landowner, manufacturer, consumer and general public; should be the public principle through and by which the cost should be distributed.

State and national appropriations for providing adequate forest fire protection, for providing scientific investigations in regard to the growth and habits of our different species, for providing forestry experts to advise private owners, are suggestive ways by which the cost of reforestation may be publicly distributed. The method involves no new governmental policy. The same methods have been employed successfully for years in connection with all lines of agriculture, animal industry, fruit growing, foreign trade, and in many other lines.

Mistakes will undoubtedly be made and failures experienced here and there, but to the extent that we are an intelligent and progressive people we will in the main succeed. We will repair any damage that has been done and then proceed to make two or more trees grow where only one or none has grown before.

OBSERVATIONS ON SOME FEATURES OF DRAINAGE AND LAND DEVELOPMENT.

BY C. G. ELLIOTT, Consulting Engineer Elliott and Harmon Engineering Company

Mr. President and Members of the North Carolina Drainage Association:

When solicited by the President of this Association to fill a number on the program, I thought of the considerable number of papers, monographs, and essays which I have prepared on the subject of drainage during the forty-four years of my practice in drainage engineering. Many of them are packed away in secluded corners, and I devoutly hoped that some one of them would be timely and appropriate for this the Eleventh Annual Convention of this Association. An examination, however, showed as it has on former occasions when I desired to shirk the labor and responsibility of presenting something up-to-date on this important subject, that the development of practice and methods of agricultural drainage in the United States have been so progressive and continuous that what was new last year is old today. For this reason I have never been able to so modify or revise an old paper on the

subject that it would fit into the program of some subsequent public meeting in such a way as to be appropriate and helpful. Not that the general principles and theory of drainage have changed, but the successful adaptation of the principles to the conditions of land and climate we meet, the improvement in design and the progress which is yearly made in the construction of works bring before us changing phases of reclamation problems which require the exercise of new thought and its expression by new literature. Really, until we take the time to review drainage methods somewhat in detail we fail to appreciate the advances we have made. Our ideas and methods of drainage were borrowed from England and Scotland. Colonel George E. Waring adopted English methods in draining the grounds of Central Park, New York, and perpetuated them in his book, "Drainage for Profit and Drainage for Health," published in 1867. A prominent landowner in Kentucky whom I visited in 1901 deprecated the fact that the perusal of Waring's book delayed him for ten years in the drainage of his farm, which at that time he had accomplished to his satisfaction. His land did not have the slope that Waring said was required for the efficient operation of drains, and furthermore, the expense carrying out such design as he found advocated in Waring's treatise would be prohibitive.

The prairies of Illinois and Indiana were thought to be too nearly level to be drained. I recall that in 1877, or thereabouts, the Chicago & Alton Railroad Company circulated a leaflet which had been prepared by Mr. H. W. H. Cleveland, an architect and engineer, setting forth the fact that tile drains would operate successfully when laid on a gradient as small as two inches in one hundred feet. I remember with what trepidation I first surveyed a drain to be constructed on that grade, three inches per 100 feet being then considered the minimum.

In this connection it should be observed that the railroads were ardent advocates of and helpful agents in the pioneer work of draining the lands of Illinois, Iowa, and Indiana. They sent representatives to the conventions, made low transportation rates on drain tile and ditching machinery, and were liberal in treating assessments which were made against their properties for carrying out public and private drainage improvements.

With these few words of introduction, I ask your permission to defer to others the presentation of technical and constructive phases of the subject, and at this time to call attention to some related topics which I have in mind.

Drainage in this State has been advanced largely through educational methods comprising public meetings devoted to the discussion of local drainage, the enactment of a State drainage law with its several amendments and through the persistent activities of this Association, I should not fail to add to these agencies the examples of satisfactory drainage which are more forceful and instructive than all others. I hold that landowners should be informed on the principles and value of all basic land improvements like drainage, but that they should call to their aid the drainage engineer when they contemplate carrying out any extended work. This suggests the training that such engineers should have and what their clients, the landowners, should expect of them. We have had the matter up with our friends at the State University. They are of the opinion that if they teach in a regular way the mathematics, the surveying, and the principles of hydraulics involved in the practice of drainage engineering they have taught the science and art of the profession as far as they are called upon to do. They then turn the student out with the advice to learn the practical part of the profession as best he can. Where will he learn and who will perfect his education in drainage? He goes out into practice and acquires the details of his profession with a varying degree of proficiency at the expense of his clients.

We have three classes in the profession: First, the well schooled technical man, who is taught to believe that mathematics should be applied to every detail, and that water should flow according to accepted formulas as taught in the books. He may or may not be able to correlate the factors and adjust his design to local hydraulic conditions. Second, the man with considerable practical knowledge gained through observation and experience with a smattering of hydraulics and a good knowledge of leveling. While assuming to be technical in his profession, he in fact does his work by rule of thumb based upon his judgment and observation. Under conditions with which he is acquainted he does it satisfactorily. Third, the well trained drainage engineer, who combines the qualities before enumerated with the added knowledge of soils and agricultural economies and experience and the practical application of hydraulics to problems of drainage. We engineers frequently place too little weight on the skill that comes from critical observation and application of facts. Technical knowledge is not always applied correctly. In my examination of plans I have frequently found radical hydraulic errors in the design of drainage works. Does not it come within the province of the school to start the young engineer right in practice as well as in technique? Give him field practice as is done with the railroad, the topographic, the geologic and the mining engineer.

There is another point I want to mention. I take the privilege of talking freely because I do not feel dependent on any political constituency or departmental machine for my subsistence or reputation. A drainage engineer should be informed upon agricultural soils and how drainage will affect their productiveness, the common economies connected with the development of reclaimed land, in short, be able to advise his clients upon all phases of drainage plans and whether or not the development will be profitable. Some lands are not worth draining for agriculture. Who should advise upon this point if not the engineer. I am not holding that he should be an expert in all of these departments; but he should know how to secure the information and be sufficiently trained to digest it himself and lay it before his clients in a clear manner.

I am aware that this view is not approved in certain high places. I have had something to do with drainage matters in the U. S. Department of Agriculture, and have been instructed that drainage engineering is devising means to get water off the land. The work ends there. If we want to know if soil has merit we should turn it over to the Bureau of Soils. Through official channels and in due time we may get a report with a mechanical analysis and an account of what is growing there and how far the land is from market and various other descriptive matter. But if it is swampy and uncultivated, we will be left in ignorance as to its possibilities, with the suggestion, perhaps, that if the land were drained soybeans or some other staple might be planted. If they grow they may make a crop. The information we most need is wanting. Do the owners want to know if the land can be developed into small farms and homes for rural population they are advised to turn it over to the promoter, the land dealer, or the immigration agent without note, comment, or advice, with the assurance that in due time that fact will become known; but if the drainage engineer assumes to investigate and advise upon those important matters he is reminded that his business is limited to outlining methods of getting water off the land.

I do not concur in these views nor in such methods. I believe that those engaged in this work should learn the physical nature of the soil and subsoil, anticipate what use it can be put to, whether the location and environment are such that the land can be profitably developed, and develop plans for draining in accordance with the facts; that the problem in its entirety should be rounded up by the drainage engineer, so that his clients may be advised of all

the facts and of their relation to each other. There is no professional work which is more varied in its details, or more subject to the modification of set rules than land drainage. We need facts and the ability to interpret and apply them correctly.

A late Secretary of the U. S. Department of Agriculture asserted with great assurance that all tile drains should be placed four feet deep because tile at such depth had under his observation proved efficient in certain localities, and also that drain tile should be soft and porous so that water might filter through the walls. The need or value of this quality was disproved years ago, and is but another instance of the progress made in practical drainage since its early days and of the failure of a man of science to keep in touch with the facts. Perhaps I should not whisper it but there are agricultural instructors and professors who now teach that drain tile should be porous so that water may percolate freely through their walls, and thus render effective drainage to the soil. It is in the old books, and some of them have not studied the later ones. I regret to confess in this connection that one of the leading civil engineers' pocket books, or more properly, hand books, in giving directions for drainage have this to say: "The tile now on the market are so porous as to offer ample opportunity for water to enter the drains through their walls."

Engineers should temper their technical knowledge with a liberal amount of practical hard-headed common sense derived from close observation. I have known trained engineers to make errors in drainage design that the ordinary workman who has acquired his knowledge by experience would not be guilty of. About forty years ago, when drainage was frequently discussed, but none of us knew anything about it, a prominent professor of civil engineering evolved and published a formula for use in determining the volume of flow and the required size of drains, with the comment that we might expect nothing more complete. It was the last word that might be expected, because it was in strict accordance with mathematical principles and hydraulic laws. I am reminded of an anecdote of Thomas Telford, the eminent road engineer, and one of the early presidents of the Institution of Civil Engineers of England. It is related of him that when on one occasion he was consulted by a young man as to the advisability of his engaging in civil engineering as a profession, he said to him, "I have made all the canals and all the roads and all the harbors. I don't see what there is that you can expect to do." While the works which had been accomplished by Telford up to that time were numerous and important, yet the great area of the Fens was then being opened up, and engineers of note were called from Holland as well as from his own country to assist in that great reclamation.

May not what I have said illustrate a failing that some of us have in handling important and expensive undertakings in drainage? We fail to get all the facts that have a bearing on the proposition. Landowners and drainage district officials begrudge the time and expense required in securing adequate preliminary data.

I have discussed matters relating to my own profession more than I intended to do. We have a placard on the walls of our office which reads, "He who makes no mistakes, does nothing; he who makes many, loses his job." Mistakes are the engineers nightmare. The tendency in some quarters is to ignore facts which will not favor our purposes. The land promoter ignores difficulties. The engineer must face and overcome difficulties, and to do so must have all the facts and give to each its proper weight. Even then he sometimes makes enough mistakes to greatly disturb his peace of mind in later years.

There is another phase of this subject which it seems to me may with propriety be referred to at this time. It has come to the attention of Congress and of those who are identified with the Government service that there is a

great waste through duplication of work and misdirected effort in the administration of the several departments of the Government, and it is proposed to reorganize said departments with a view of establishing a regime which will increase efficiency and economy throughout. It is quite clearly evident and has been apparent for several years that such a reform is needed. However, under the existing order of affairs in the U. S. Department of Agriculture, there are wastes which are not the fault of organization but of administration of the several bureaus. There are experiment stations in every state in the Union which are supported by Federal appropriations frequently supplemented by liberal additions by the states. An immence volume of experimental work and investigations are carried on by the several bureaus and Federal stations. The shelves of their quarters are loaded with data, notes, measurements, and illustrations, which have been turned in according to instructions, and are apparently pigeon-holed for all time. No attempt is made to sift out the facts, digest them, and make them useful to the locality from which they are obtained. They are dead goods and the labor employed in securing the facts has served no useful end to the people. If a bulletin is issued on some subject, not infrequently it is divested of live and pertinent facts, and the generalizations on the subject are substituted, which fill up but do not enlighten the reader. To illustrate, there is a rule that no facts resulting from investigations relating to subjects peculiar to the needs of North Carolina can be made public until the same are available to the people of California, and all other parts of the country. To do so might give some section advance information, and hence an advantage over another. Directions are further given that no bulletin should be issued until the subject therein treated contains all that can be said or ever will be said on that subject. It must be a complete compendium. It must be the work of experts who have learned it all. Hence it is that there is a store of valuable facts in the Drainage and Road Office, and in every other bureau of the Agricultural Department, including the state stations, which is salted down and useless. It is not necessary to express a conclusion if the facts do not warrant it nor evolve a complete treatise on a subject whenever an investigation is made. Facts are the bases of practical operations. Agricultural investigations are always local in character. The people of one locality are not particularly interested in the difficulties which those of other localities are obliged to meet. Why wait until in the course of governmental events a well prepared dissertation has been prepared and issued at large cost and distributed to the people at large when the matter therein contained is of use to not more than one per cent of the people. Some of the vital and controlling facts given in the locality which was covered by the examinations, if timely, might have been useful. There are just as competent men outside the bureau as inside, and their coöperation would strengthen the investigation. So I would say give us the facts with their local environments in an intelligent form and let them be continuous and timely. Strange to relate, there is a dislike on the part of those engaged in public work to acknowledge that they do not know all there is to be known on the particular subject. I have been interested at the efforts of some of our scientific observers in the invention of an excuse for withholding a conclusion derived from the data he had. In one instance I could name, the investigator attempted to account for a flood, and after a lengthy discussion of the facts that were available, including rainfall records covering a period of forty years, he confessed that the rainfall record was so meager that additional data along that line would be required. The inference is that we must wait another forty years if we are to have his assistance. In the meantime we would use the facts if we could get them and work out the problem as best we may until better data are secured.

There are several large reclamation projects under way in Eastern North Carolina, and other meritorious ones remain to be worked out. Those interested in them are concerned in securing farmers who will occupy the land as soon as it is drained and who will bring it into production. It goes without saying that unless land is put into productive use, its drainage will be a financial loss. The settlement of newly-opened-up lands by good farmers is the most important problem now connected with the permanent development of the lands in Eastern North Carolina. When a part of a farm which is already occupied, equipped, and operated is drained, there need be no delay in fitting newly-drained parts for some useful purpose. But not so with large and more or less inaccessible areas of cut-over swamp lands. The making of farms in such locations means pioneer work, work entirely different from that done by farmers on well improved lands which are contiguous to the conveniences and many luxuries of modern life in the agricultural districts. The new lands must be ditched and some part of them made to produce a crop as quickly as possible. A few necessary though not elaborate buildings must be put up, some livestock brought in, and roads built. Assuming that the public ditches have been made and the land subdivided into tracts of suitable size for farms, the question arises as to how it may best be successfully and permanently settled? In the case of ten thousand acres or more it means a new community with its attendant social and political organizations. We should not forget that settlements will be made up of people of average attainments, not of men possessing initiative and unusual ability in conducting their business. The quotation is frequently used, "What one man has done another can do." This is not true in a practical sense in land development. We must deal with average farm conditions and with such men as will be attracted to these lands.

We have the colonization method, which consists of gathering a company of families who have certain national, religious, or social bonds that unite them and make their associations attractive. While this plan has been satisfactory in some instances, it has failed in others. Lack of thrift on the part of some members, or unforeseen adverse conditions of a general character which affected all have sometimes discouraged the settlers, who abandoned their holdings.

There is the time honored method of individual settlers who, upon receiving reliable information regarding the locality, seek the place knowing what they want and what they can do. They settle down to the work with a partial appreciation at least of the task that is before them with a knowledge of their business and faith in the benefits they will finally secure if they persevere. Happy is the district where such people cast their lot. If large tracts which have been reclaimed at a considerable cost under drainage organizations are secured by speculators, that is, by those who do not intend personally to utilize them, but sell to the actual farmer as occasion may offer, the reclamation is delayed and the price of the lands to those who later must fight the battles incident to the making of farms from the raw land is increased.

In this connection I feel like registering a protest against certain teachings of the agricultural press and of lecturers on modern farm life. They tell us that people cannot be expected to go on the land and be farmers in these days unless they can be supplied with city conveniences, such as hard roads, lights and waterworks, sewers, etc. They condole the lot of those who are compelled to do without them, and censure those who fail to keep their home establishment equipped with modern improvements. They compare the home and surroundings of the well to do farmer with those of the pioneer on new land to the disparagement of the latter. It should be remembered that farm life has an atmosphere which is wholesome and peculiar to itself; that town amuse-

ments and bright lights are not necessary nor even conducive to the development of character or happiness of the occupants of the farm. They teach that more than eight hours labor in a day works great hardship and an injustice on the farmer be he owner or laborer. They decry the farm tenant system as pernicious to progressive agriculture. Some of our self-constituted teachers in rural affairs are too academic. They know little of practical affairs relating to land and agriculture. They regard the flash and frivolities incident to town life as a necessary adjunct of farm life. If these teachings prevail, and they are being widely disseminated, we may look in vain for the settlement of our new lands which require initiative, hard and persistent labor and more or less privation in the beginning. We will see a congestion of people in and near the towns and cities while the broad acres of the Carolinas will remain unoccupied and unused.

This State has lands which should be attractive to those who can appreciate their value and at the same time can understand the difficulties of thoroughly reclaiming them. I venture the opinion that the high selling prices of the older farming lands, and the inability of many to maintain the luxuries of the higher farm civilization in our older sections in which national and local high taxes will be an important factor will result in some radical changes in ownership and management. The land will produce no more, but the cost of operating will be greater. Luxuriant farm homes, very desirable in themselves, and high class schools, roads and other desirable requisites will entail more expense than some will care to carry. They will then turn to the new and cheaper lands such as the Carolinas offer and find prosperity and contentment in them though their immediate surroundings may lack some of the modern improvements of the age.

TILE DRAINAGE

BY H. M. LYNDE, Senior Drainage Engineer

The United States needs more drainage. North Carolina needs more drainage. Eastern North Carolina is particularly in need of more drainage, and by more drainage is not necessarily meant more land reclaimed. There are hundreds of thousands of acres now under cultivation in the State which need better farm drainage to produce maximum yields. While this is probably not the time to speak about increasing our production, in view of the low prices now prevailing for southern products, yet we must realize this condition is only temporary and that all the easily developed portions of the country are being utilized. There has been and will be again a time when we must increase our production to take care of the increasing population. Everybody here must admit that this is the primary purpose of the North Carolina Drainage Association.

We must increase our production in two ways: first, by reclaiming the swamps; second, by intensifying production on land now under cultivation; and one of the means of doing this is by better internal drainage of the soil, which is a subject not related merely to the removal of surface water. The basis of good soil management is a correct water supply, not too little or too much, but the right amount at the right time.

The ideal system of drainage is one which is adequate, not a hindrance to cultivation, and uses the least possible land. Such a system is most nearly secured by the use of tile drains. Although there is urgent need for tile

drainage in all the Coastal States from New York to Florida, comparatively little along this line has been done. This being the case, it would seem that this is the year of all years to make permanent improvements—this year while labor cannot be profitably employed making "money crops." As the *Progressive Farmer* stated in a recent issue, "If a farmer wishes to clear, ditch, tile or terrace land, this is the year to do it."

Let us look at this question of tile drainage honestly and fairly. Tile drainage is being practiced on a very limited scale in North Carolina; and why? Probably the principal reason why tile drainage is not more generally practiced in this State is because the great results to be obtained from under-drainage are not generally understood. Another reason given by the man who appreciates the value of under-drainage is that he has not the ready capital with which to do the work. One man says that tile drainage is too costly, that the land is too low in price to pay for such a seemingly expensive improvement. Another says that it will stop up anyway if you do put it down. Some think that they are getting good enough drainage by the present methods. The problem in this State, in my judgment, consists largely in inducing the farmer to change from an old method to a new method of drainage to convince him that tile will drain better than open ditches.

In the Middle West, in the beginning, those farmers who installed tile drainage systems were considered highly adventurous and foolish. These early systems, however, have been the cause of an ever-spreading realization of the need of under-drainage and of its benefits. Iowa alone, in 1916, according to a report on "Clay Working Industries," published by the U. S. Interior Department, produced $4,000,000 worth of drain tile, while North Carolina produced only $18,000 worth, hardly enough for ten fair sized farms.

Tile drainage will increase crop yields for the following reasons:

1. It lengthens the growing season.
2. It increases the benefits of fertilizers.
3. It gives better soil ventilation.
4. It prevents crops from drowning out.
5. It safeguards crops during drought.

Another thing that tile drainage does is to increase the area of the farm and simplify farming operations by doing away with the open ditch. Many farms, no doubt, in this section have nearly five acres out of every hundred occupied by ditch and bank. I honestly believe that tile drainage will pay for itself in about six years from the crops raised on the narrow strips redeemed from open ditches.

After all the usefulness and helpfulness of tile drainage is not measured by what we *promise*, but by what it performs. No one is so well qualified to speak of the value of tile drainage as those who have tried it. We have with us today some men who have tried it, and I am going to call on Mr. Cline, Mr. McCotter, Mr. Shook, and Mr. Latham.

TILE DRAINAGE IN OUR BLACK LANDS

BY A. S. CLINE, Assistant Director Branch Experiment Station

The question has sometimes been asked as to whether tile drainage is practicable in the black muck soils of our reclaimed swamp districts. Two possible objections to it have been raised: one, that because of the extremely flat grades

necessary in laying the tile, this tile would tend to fill up with muck seeping through; and the other, that as the black soil settles the tile lines would sag out of grade and spoil the drainage.

However, the experience we have had with the use of tile on the Black Land Station of the North Carolina Department of Agriculture, located at Wenona, N. C., is a sufficient answer to the objections. Its operation has been an unqualified success. Three and seven-tenths miles are now in use on this farm. This tile is laid at a minimum depth of four feet. On this farm the depth to clay is 3½ feet, so the depth used allows the tile to be firmly laid in a clay bed which precludes the possibility of it ever settling out of grade. The grade used varies from ½ inch to 1 inch per 100 feet. The lines are spaced 330 feet apart, this being the standard spacing for all open ditches in this community. On the first part of the farm drained only a main, with no laterals, was used. With the latter drainage a main with laterals at right angles, spaced the same distance apart as the mains, is being used. Size of tile used varies from 4 inches up to 15 inches; but we have arrived at the conclusion that 5 inches is the smallest diameter advisable to use in muck soils. All outlets are in the main drainage canal.

The first line, consisting of 4 and 5-inch tile, was laid in the spring of 1915. After six years use, it is working perfectly and no objections to it have been found. The second line, of 4 and 5-inch tile, was laid in the fall of 1915. In the third main, laid in 1916, 5 and 8-inch tile were used. The fourth line, laid in the summer of 1919, was 10, 8, and 5-inch tile, while the laterals emptying to it are of 5 and 4-inch. The fifth and last main laid in the fall of 1920 will drain 110 acres; 15, 12, and 10-inch tile were used in this. The grade of this main is ½ inch per 100 feet. With this almost flat grade, the tile is working perfectly.

The cost of tiling varies somewhat with the size of tile used. For the work done in 1920 an accurate record was kept, and the cost, exclusive of tile, was 15.4 cents per running foot for the laterals and 20 cents for the main. Labor was based at 36 cents per hour. This soil is full of wood, especially cypress stumps, which increases the cost of cutting ditches materially. Prices of tile can be secured from factories. The 15 and 12-inch tile purchased last year cost 71 and 48 cents, respectively, per foot. This was No. 2 sewer pipe, as farm tile of the diameter mentioned cannot be secured in this State. For the work done last year the per acreage cost was $18.57, exclusive of cost of tile. With the prices paid for tile in this case the total acreage cost is $36.03.

In preparing an article recently for the *Southern Ruralist* on Tiling vs. Open Ditches, I found a yearly saving through no recleaning of ditches, no loss of land from cultivation, and no cleaning of ditch banks. Other benefits, as more thorough drainage, larger fields, rendering cultivation easier, no wintering place for noxious weeds and injurious insects, and no breeding places for mosquitoes, cannot be easily expressed in values of dollars and cents. However, using only the values I mentioned it will be seen that tiling will pay for itself within 14 years of use. When we know that many tile lines have given, and are giving, good service for 40 years or more, we have the answer as to whether tile drainage will pay in our black swamp lands.

No trouble from muck seeping through has been encountered on the station farm. An examination of the tile after a year's use showed it to be perfectly clean, there being no sediment in it whatever. As a matter of fact, this muck soil does not tend to seep through as does sand and silt. With many things to be said in its favor, and any possible objections yet to be discovered, I unhesitatingly say that tile drainage for our muck soils is a most profitable investment.

SUCCESSFUL USE OF TILE DRAINAGE

BY D. C. McCOTTER

I have recently completed laying tile on one of my farms on which I have previously used open ditches, and I am much pleased with the results accomplished in tile drainage. It has more than doubled the value of my farm. Since laying the tile I have had good opportunity to test it out by reason of several very heavy rains which caused the overflowing of farms adjoining mine which had open ditches and the water stood on the farms with open ditches while my tiled farm was free from water. I also find that I can begin plowing twenty-four hours earlier on my tiled farm than I can on the farms with open ditches, notwithstanding the open ditches are in perfect order.

Furthermore, in the hundred acres which I have tiled I have a great many more acres in cultivation now which formerly were in ditch banks, and ditch banks are certainly expensive to keep in order, and yield no profit whatever.

I have been very careful to see that my tiled farm was properly put in and have spared no expense in seeing that it was done properly. I used plenty of straw over my tile after it was laid in the drain, and also used a cheap grade of roofing, placing small strips of same over each joint, and I certainly recommend the use of this, as my mains have been running clear almost ever since the day they were put in, which shows they are free from any obstruction.

I tiled this farm at a time when both labor and materials were very high, therefore the expense was greater, costing about $50 per acre; but I certainly do not regret this expense, as I value this farm at least $150 per acre more now than before being tiled. I cannot recommend too strongly the great advantage in the use of tile drainage, but would advise the use of clay tile.

EXPERIENCE WITH TILE DRAINAGE IN THE COASTAL PLAIN

BY L. W. SHOOK, Manager Cotton Valley Farm, Tarboro, N. C.

In 1916 and 1917 we laid many thousands of feet of tile on Cotton Valley Farm, replacing some six miles or a little more with about ten miles of tile. All of our land is very level, and in some cases we found difficulty in getting enough fall and also in obtaining suitable outlets. The land that we tiled was of two general soil types—the Norfolk and the Portsmouth. Some of the Norfolk soils were very variable in character and hard to drain on account of this variability. This was particularly true in one 30-acre field where pockets of coarse sand and sandy loam were thickly interspersed with pockets of stiff gray clay that was almost impervious to water. Often there were as many as a half dozen different kinds of soil in a linear distance of 100 yards. In wet weather these clay spots were regular loblollys, and in dry weather as hard as a brick. These areas are still rather wet, stiff, and hard to cultivate, but they are a great deal better drained than they were with open ditches. It is our purpose to lime this field this year and plant it to soybeans in order to improve its mechanical condition. Before tiling this field had been abandoned for several years, but it has grown a fair crop every year since it was tiled. We believe that with the addition of lime and humus we can have it producing good crops in another two years.

The most striking results from tiling that we have obtained were from a big Portsmouth bottom in the middle of a fifty-acre field. This bottom had no natural outlet; and, though very fertile, was very wet and hard to cultivate, and it was very rarely that good crops were obtained on it. Immediately after tiling, it became the driest part of the field and has produced excellent crops every year since.

Our results in other fields have been between the two instances cited above.

The advantages we have obtained from tiling are as follows:

1. Some areas have been made safe for full crop production that before tiling were almost sure to fail.

2. Some areas have been made to produce fair crops that before tiling had been abandoned.

3. By filling up the open ditches about ten or twelve acres have been added to the tillable area of the farm.

4. It is cheaper, easier and much more satisfactory to cultivate the fields since the open ditches have been eliminated. This saves much time in turning around at the end of the row and in going around the heads of ditches or to bridges to get to another part of the field. Twenty odd farm bridges have been done away with. The maintenance of these bridges alone was no inconsiderable item in the old days before we tiled.

The biggest mistakes we made were:

1. In not filling up the open ditches before tiling. We think this would have been a great help in our case, though it might not make so much difference under other conditions.

2. In not giving the tile fall enough in one or two cases.

3. In getting the tile too near the surface in one instance.

On the whole, we think it has paid us to tile the farm, though the results have not been what we expected in some cases. However, if we had it to do over we would not hesitate to do it, and we are sure we could do a better job the next time than before.

RESULTS OF TILE DRAINAGE IN EASTERN NORTH CAROLINA

BY F. P. LATHAM

Mr. President and Gentlemen:

In the outset of this discussion it is my desire to make it entirely informal, and I extend to all the privilege of a question, and an open analysis of facts, as I feel that much more can be gained in this manner than by a set and prepared statement. I may not be able to answer some question; however, this will not in the least embarrass me, as I know of no one who has a license to possession of all the facts pertaining to the problems of tile drainage.

I desire to state that my knowledge of tile drainage is the direct result of practical observation of a system begun fifty years ago on the same farm upon which I was born, and still reside.

The surface of this farm is much like a great majority of the farms of Eastern North Carolina, level, and consisting of a sandy, clay-loam soil; that tile will do an efficient service, and a continued one, has been fully demonstrated by all these years of satisfaction; in fact those tile that were laid before my day, are if possible, doing better service than a new system, inasmuch as a water-free soil invites the roots of plants and burrowing insects to construct millions of minute channels, a condition impossible in a water-soaked soil, through these the water seeks the point of its level.

Observing the beneficial results of this system laid by my father induced me to undertake further work on some lands not previously drained, on this last work the land was almost totally devoid of fall, hence the grade had to be made without the benefit of natural advantages, some of these leads were longer than I care to put in (2,600 feet) ; however, by the use of a farm level, and doing the final grade and laying the tile with my own hands, I now have the satisfaction of enjoying the benefits of efficient drainage, enabling me to produce creditable crops where before profitable farming was impossible.

To the question of cost per acre, of course this item depends greatly upon cost of labor, tile, etc.; however, with $20 per thousand for tile as a basis, the cost in a reasonably porous soil should not exceed $12.50 per acre for general crop production. However, this must remain for the individual to work out on his own farm to fit his specific requirements.

We must always bear in mind that there is a clear line of demarcation between intensive and extensive agriculture, and what might be absolutely necessary for the profitable production of the intensive culture crops of truck and vegetables, might bring the cost a bit high for the general staple crops of corn, cotton, beans, etc., which can stand a little more punishment from temporary excess moisture, having more time for complete recovery.

Where this is likely to occur some provision to take care of the occasional downpour by surface drainage is often advantageous.

With tile properly placed in a soil through which water readily descends, and with an open outlet, where the silty water from surface drains do not back up the lead with pressure before the water from the surface reaches the tile, and where a true grade of not less than two inches to the hundred feet has been maintained, satisfactory drainage should result for ages with little thought of attention and maintenance.

I know of no other investment on the farm so permanent that is a revenue producer all the days of the year that compares with the satisfaction derived in cultivating all over your ditches without worry that will yield a better interest on investment than a well planned tile system.

In closing I wish to say that unless the individual has had actual experience it would be risky and entirely unwise to undertake the planning and putting in of a system without the aid of an engineer or some practical man who has had actual and successful experience in such work.

DRAINAGE VS. MOSQUITOES AND MALARIA

By Dr. T. H. D. Griffitts, U. S. Public Health Service

It is not recorded historically that the crew and passengers of the Ark were pestered by mosquitoes.

In round numbers, however, there must have been an infestation by at least 1,000 of these disreputable creatures. For of the 500 species of mosquitoes the old ship must have harbored a male and a female of each kind. This would have allowed a minimum of 1,000.

It seems certain, then, that the good old Mariner Noah, in executing the command to take a male and a female of each living creature aboard, rounded up this thousand. Or, perchance, there was a violation of the "sanitary code" in permitting the presence of discarded tin cans holding water, fire barrels, or like receptacles, where these damnable, pesky, and disease-purveying insects bred and infested the boat before sailing.

Let's throw the mantle of Christian charity about the entomological knowledge of those deluvial days and assume that Noah did not set the stage inten-

tionally for all the bad acting the multitudinous hordes of this perditious family have inflicted upon the species of the *genus homo* down through the ages.

No man can portray a hatred for mosquitoes more than one whose hatred is vehemently venting from a spleen argued from their malarious bites.

But have you ever contemplated the good even in a mosquito?

Only half of them bite—the females. The males do not. That's good, and the only good I know of.

And again, only a small proportion of the females of the hundreds of species are even capable of carrying disease about in their system. To most people a mosquito is simply a mosquito. But she has been a ruling influence in the destinies of empires, the collapse of military expeditions, the failure of national enterprises, the undevelopment of agriculture, the mortality rate, the throttling of prosperity and the disturbance of rest. She is the subject of conversation in any society; she will make your acquaintance readily and alike on the Ganges and the Yukon. She pumps the blood from the Eskimo while her distant relative imbibes a sanguinary luncheon from the Ecuadorian in siesta. She requires blood to stimulate egg-laying for the propagation of the species. And blood she gets.

With this foreword that suggests a mosquito is more than simply a mosquito, let us consider her in her relations to man and his well-being. For just practical reasons, these insects are divided into two general classes—disease carrying and nondisease carrying, or, for the present in the United States, into Anopheles and Culex.

The Culex pesters, the Anopheles carries malaria ("chills and fever") from the person infected with malaria to the well person, through her contaminating bite.

True, there is another variety still existing in this country that was in times past an object of grave concern, the little zebra-legged yellow fever carrier. She is here yet, but since there is no yellow fever for her to "tote," we pass her up and think of her damage only in retrospective moods.

But the malaria mosquito continues to purvey malaria in the South, and inserts her proboscis into the very purse to the tune of millions of dollars annually in economic loss.

For more than two decades the Anopheles mosquito has stood convicted of the crime of malaria, but her execution has been deferred. However, her liberties have been restricted, and both the area and degree of prevalence of malaria are today decidedly reduced under that of twenty or ten years ago. In some sections of the country it has entirely disappeared. In practically all portions there is a steady, permanent decline.

More and better farm drainage is being installed, connecting up agricultural with health drainage; homes are being screened to keep out the malarial mosquito along with her ally, the nasty, disease-carrying house fly. Prosperity and enlightenment have brought about a more general use of quinine and more permanent cure of malaria-infected cases.

According to historians, malaria in this country dates back to the Jamestown colony. It is believed malaria was one of the hands of death that laid hold of the colony when in the first eight months of their struggles sixty-seven of the original settlers died.

Cold weather checked the frightful illness and mortality. This disease, along with yellow fever, it is thought, was brought to the shores of America by ships that touched at the Antilles, members of the company getting infection there.

There are 189 separate and distinct ways by which we take sick and die, according to an international classification of the causes of sickness and death. In other words, let us say that it is a great drainage system by which

humanity is drained into eternity. As health engineers, we should plan and construct and maintain this system according to good engineering knowledge. Let us establish "old age" as the outlet channel and not allow it to become obstructed. Imagine the expense of a drainage system where every farm ditch must drain separately to the ocean. Then contemplate the waste of humanity where the old-age channel or outlet is obstructed and we get deaths by typhoid, malaria, tuberculosis, smallpox, pneumonia, and the appalling infant mortality—preventable diseases—that must be connected up with the natural drainage system. We must get away from this expensive system. And you in the Old North State are doing it.

Malaria is an absolutely preventable disease. It is one of the greatest single factors operating to retard development and progress in the South. It is wonderful development to do agricultural drainage, to lower the water table in this great section of "geological cream." We must go one better, and at the same time construct and maintain the drainage so as to keep down mosquito production with its consequent malaria. Use of tile drainage on farms is loudly called for in permanent malaria eradication.

Here let me say that Anopheles (malaria-carrying mosquitoes) like fairly clear, clean water, even fairly deep water, and the ditches and canals with quiet water, with cat-tails, bullrush, and the like, present ideal conditions for mother Anopheles to lay her eggs and raise her hordes of disease purveyors. Much malaria in the coastal section is "man caused"; wide-bottom canals and ditches that merely serve to hold water, and, probably, lower the water table; that serve as sumps or are a series of pools at low water stage, are a menace to health. Unemptying roadside ditches, undrained borrow-pits and high culverts that impound water may be found even along some of our new "good roads." I say that *no road is a good road that contributes to ill health along its course*, to the production of malaria-carrying mosquitoes.

It's a sad commentary that more than two decades after the simple cause of malaria transmission was known you can go into communities in this year of our Lord and find amongst otherwise intelligent people a deplorable prevalence of malaria; men in the field, in the shops, in the stores, on the streets, children in the schools, trying to work, trying to study—sick and don't know it, from a disease that prevails only through ignorance and inertia. I know of such a place where one church subscribed $30,000 to foreign missions and refused to spend $4,500 to get rid of malaria that was thwarting progress, shackling the mentality of its future citizens. One feels like saying, let the grown-up "old stiffs" suffer if they like, but how about those for whom they are responsible? Now, I believe in church work; I like the idea of foreign missions—it's a glorious work. But I do say that if we neglect such conditions as I have mentioned right in the shadow of our churches, in our own American communities, and call it Christianity, call it religion, then I don't sign up.

If I were an artist and could convey to the canvas my conceptions I would paint a monster, stalking through the Southland destroying crops, frightening farmers from the fertile lowlands to the worn-out hillsides, smashing industries and choking prosperity; displacing pleasure with misery; laying waste to 25 per cent of the school terms; supplanting childish frolic with funeral processions; I would place in his left hand the flickering taper of ignorance, in his right the wand of welfare inertia, on his head a sepulchral crown, at his feet water-soaked soil of greatest fertility, and I would give it all the title of "Malaria."

Gentlemen, go with me to the East, to the Northwest, and what do you hear of this section and other sections of the South? That we have all the advantages for the sturdy, progressive farmer, except that they fear malaria, "chills

and fever." We must remove the cause for this apprehension. We must drain malaria out by doing mosquito drainage along with the agricultural drainage; then bid the thrifty immigrants from the North, East, and West to come with their families to this land of great opportunities—and they will come.

The following paper was read and discussed in connection with Dr. Griffitts' address, and the convention requested that it be published as part of the proceedings.

MALARIA: LESSONS ON ITS CAUSE AND PREVENTION

FOR USE IN SCHOOLS

By H. R. CARTER, Senior Surgeon, United States Public Health Service

INTRODUCTION

Teaching some of the facts about malaria in schools is not new. It was done in San Antonio in 1904 after the yellow-fever outbreak of 1903, when the writer first had cognizance of it. There are chapters on malaria and mosquitoes in most of the textbooks on hygiene used in the public schools.

This paper is, however, intended to be rather more complete than the chapters devoted to malaria in the textbooks mentioned, as the importance of the disease seems to demand. Without question, in many parts of the United States where malaria is prevalent it is more important and does more injury than all other diseases combined, and measures for its control should be emphasized. As the campaign for the control of malaria is likely to be a long one, it seems very advisable so to educate the rising generation that they may bear their full part in it. Knowledge of malaria, how it is conveyed, and how it may be controlled, if generally spread among all the people, will ultimately compel the control of malaria.

This paper was submitted to Surgeon von Ezdorf, Public Health Service, and has received the benefit of his suggestions, many of which have been adopted, and the writer only regrets that Dr. von Ezdorf's departure for Vera Cruz prevented his review of the entire paper.

I wish also to acknowledge my indebtedness to my secretary, Miss Laura A. Carter, who was really a collaborator in this work, and to Miss Ethel Neely, secretary of the Virginia Society for the Study and Prevention of Malaria, who kindly allowed me to examine a course of excellent lessons for schools prepared by herself. The arrangement of her course of lessons—questions and answers—is followed in this paper as being better for school use than a connected narrative with the questions subjoined.

These lessons, or rather this catechism, on malaria are presented, then, for use in schools, especially those in the country, either as they are written or as a basis for lessons more suitable for the different needs of the schools in different sections.

TO THE TEACHER

It was at first intended to make these lessons only for children and consequently very simple; to make them *true*, however, required either to make them less simple or to trust to the teacher to explain difficulties, and answer questions that would naturally arise. Now it may be that some of the teachers will not have sufficient knowledge of the subject to answer the questions which will be asked and give the necessary explanation—for accurate knowledge on

even the rudiments of this subject is not so common—and on this account this little paper is intended for both pupils and teachers. The questions marked (a) are intended only for the pupils. The others (b) are for the teachers, and deal with ideas a little more complex than the others, yet not especially so. They contain facts, however, which a teacher must know to understand the subject at all. Some are marked (a)? as the writer was unable to decide whether they should be marked (a) or (b).

Teachers, however, will use their own discretion in giving to pupils such of the questions intended for themselves as the age and intelligence of the class may justify.

Each school should form a field class among the pupils, studying malaria to find the larvæ of the different kinds of mosquitoes, and to identify them and to learn to recognize the different kinds of places in which they breed; where the eggs of the different families of mosquitoes may also be found and identified.

Culex mosquitoes will be found in almost any standing water, especially in rain barrels, in pools and puddles almost anywhere. *Aëdes (Stegomyia) calopus* will be found in artificial containers about houses. Anopheles will be found in the clean, shallow, shady, grassy pools described. The first two can be seen at once and recognized as not being Anopheles by their position, hanging head downwards. If one leans over a pool containing Anopheles and waits a little he will be able to see these larvæ lying flat at the surface of the water. He must wait a little, however, as they are apt to dive when one approaches them; also they frequently run to the edge and hide in the grass, so they are sometimes not so easy to see even when present. The best way to get them is with a dipper and a white saucer. *Dipping* in the water unless you see larvæ is not the best way; make a quick stroke, just skimming the water towards the edges of the pool. Carry it into the grass, because the larvæ are in the grass. Do not make this stroke until you have given the larvæ time enough after you arrived to dive and come to the top. Another way is to press the edge of the dipper suddenly under water, so that the stream of water running into it may wash the larvæ into the dipper. Pour the contents of the dipper into the saucer and you will see the larvæ against the white ground. The young Anopheles are light grey, banded with black and very slender. The older ones are red, green, black, etc., the color depending on what they eat. They are less slender. All are quick in movement, and although they will dive, yet they also dart along the surface of the water, which the others never do. Some are extremely small.

The eggs of Culex are easily recognized, being brown rafts half as large as the nail of one's little finger. The eggs are set on end in the mass. They are common on water barrels. Anopheles' eggs are in loose groups, the eggs lying flat on the water singly. They are very much harder to find and require a hand magnifying glass. They are usually demonstrated by keeping Anopheles mosquitoes in a jar with water at the bottom, on the surface of which they will deposit their eggs. Eggs may occasionally but very rarely be found in nature on the surface of water containing many very young larvæ. Dip this up in a saucer and examine with a hand glass.

Keep them in a vessel with a wide mouth—fruit jar, candy jar, etc.—half full of water or less, with pieces of grass in it extending above the water. Cover it with mosquito netting and some of them will develop into mosquitoes, and you can tell the kind. The larvæ are cannibals, and the big ones eat the others. Anopheles are much harder to raise than Culex, and unless one starts with nearly full-grown Anopheles larvæ or pupæ it is difficult to develop the mosquitoes from them unless one takes a pan or trough and makes enough of a marsh to imitate natural conditions. Some of the points of difference of mosquitoes and larvæ can be seen with the naked eye, but a good hand lens is of great assistance and makes the study much more attractive.

The pupils should be encouraged to do such antimalarial work as is practicable to them. That directed against mosquitoes is the most practical; compositions on subjects connected with the lessons; verbal reports—say, weekly—during the malarial season of what each one has done in the way of antimalarial work will increase the interest in this subject. The fuller the knowledge the teacher has of the subject, and the more it is explained and developed the more the pupil will be interested and will profit.

MALARIA

SECTION I.—MALARIAL FEVER AND ITS CAUSE

(a) Q. *What is malarial fever?*

A. A disease of man, common in hot, wet countries.

(a) Q. *What is malarial fever sometimes called?*

A. Chills and fever, bilious fever, swamp fever.

(a) Q. *Is this disease found in the United States?*

A. Yes. Along the coastal plain from Connecticut to Texas, over nearly all of the Mississippi Valley, and in a number of valleys on the Pacific coast.

(a) Q. *What causes malarial fever?*

A. The presence of certain small organisms in the blood of the person who has the fever.

(a) Q. *What do you mean by an "organism"?*

A. Something that is alive and thus has the power to reproduce its kind. It may be alive as a plant is alive, or alive as an animal is.

(a) Q. *Is the organism which causes malarial fever a plant or an animal?*

A. It is an animal, and in the blood is said to be an animal parasite.

(a) Q. *What do you mean by a "parasite"?*

A. An animal or plant that lives at the expense of another, like the mistletoe, love vine, rust on corn, or the hookworm, flea, etc. The malarial parasite lives in man only by feeding on the blood cells of the man.

(a) Q. *How do you know that these parasites are found in the blood of those who have malarial fever?*

A. Because with the microscope we can see them in the red blood cells of a man sick with malarial fever.

(a) Q. *What do you mean by red blood cells?*

A. They are very small bodies floating in the blood, shaped much like a biscuit, with thickened edges; they give the blood its red color, and are a most important part of it. They are essential to life.

HOW MALARIAL FEVER IS TAKEN

(a) Q. *How do these malarial parasites get into the blood?*

A. In one way only: Through the bite of a mosquito. Malaria is not acquired by eating improper food, by drinking bad water, by bathing in the sun, or in any other way than by the bite of a mosquito. True, if one already *has* malaria, that is, *has these parasites already in his blood*, doing these things will develop it—"bring it out"—so that he may have a malarial attack which he could otherwise escape, but only if he is *already* infected with malaria.[1]

(a) Q. *Do all kinds of mosquitoes transmit malarial parasites to man?*

A. No, only Anopheles mosquitoes carry malaria, and only some kinds of Anopheles.[2]

[1] The teacher should here tell the class of the conveyance of malaria to Dr. Patrick Manson, Jr., in London, by mosquitoes infected in Italy and brought thence to London, of the experiments of Sambon and Low at Ostia, living all summer in a screened house and keeping well, although drinking the same water and eating the same food, and in all respects except housing living like their neighbors; and give them other evidence as may be necessary to show that malaria is conveyed only by the mosquito.

[2] Classification of Howard, Dyar, and Knab.

(a) Q. *Are mosquitoes born with this power of conveying malaria?*

A. No. They acquire it only by biting a man who has these parasites in his blood. The parasites are taken then from a man by a mosquito and go back from the mosquito to another man. Where the parasites first started we do not know.

(a) ? Q. *How, then, does malaria spread?*

A. Exactly like yellow fever. A female mosquito of a certain kind feeds on a man infected with malaria and sucks up blood with malarial parasites in it. She can not convey malaria to those whom she bites for some days (a week or more) after this, but after waiting a while (the reason for which will be told later) she injects these parasites into other men whom she bites and infects them with malarial fever.

(a) Q. *What, then, is necessary to spread malarial fever?*

A. Anopheles mosquitoes; malarial parasites and healthy men. The parasites may be either already in the infected mosquitoes or in infected men, from whom the mosquitoes can get them by biting.

How to Tell Malarial Mosquitoes

(a) Q. *Do both male and female mosquitoes bite?*

A. No. The female bites. It is doubtful if the male ever bites.

Q. *Can you describe the head of a mosquito?*

A. All mosquitoes have a bill and two *palpi* (*pal-pee*), which lie close to it, one on each side. Outside the palpi are two *antennæ (an-ten-nay)* which spread apart. The antennæ of the male are plumelike. Those of the female are not.

Q. *How then can you tell the male from the female?*

A. The male has "plumes on his head."

Q. *How can you tell the Anopheles, malaria-bearing, mosquitoes from the Culex and other kinds in the United States which do not convey malaria?*

A. One way is by their heads. Anopheles have straight bills and palpi nearly as long as their bills. The females of the other kinds have short palpi, except one kind which has a curved bill. The males of both Culex and Anopheles have long palpi, and one can not tell the species of the males in this way.

(a) Q. *Are there any other differences?*

A. The malarial mosquito is slight and graceful. The wings are generally spotted or dusky.

(a) Q. *Is there any other difference to note?*

A. Yes. The way of resting on a wall. Anopheles rests in a straight line, frequently standing on her head. The others rest "humped up." This is the only way that can be used to tell the live mosquito, and is the one usually used in practice.

(a) Q. *Can you tell something of her habits while feeding—on man, I mean?*

A. She rarely bites in the daytime in the United States. The day mosquito of the South is *Aedes* (or *Stegomyia*) *calopus*—the yellow-fever mosquito. Anopheles is shy and easily driven off, and will rarely bite one who is moving about, hence is most apt to bite one who is asleep. Her bite is less painful than that of other mosquitoes, and she does not sing so loudly. On this account, when mosquitoes are much complained of they are rarely Anopheles, and there can be many Anopheles about without much complaint.

Breeding of Mosquitoes.

(a) Q. *Where do these mosquitoes breed?*

A. In water—in still water and in the pools and grassy edges of running water.

(a) Q. *How do these mosquitoes breed?*

A. They lay their eggs on the surface of the water. These eggs float, and in a few days hatch into larvæ, or "wiggle-tails." These live in the water, and in time turn to pupæ, or "tumblers," which turn into mosquitoes. There are four changes in the development of mosquitoes just as for butterflies; the eggs for both; the larvæ in place of the caterpillars; the pupæ in place of the crysalis, and the mosquitoes in place of the butterflies. For mosquitoes all these changes must take place in water, and for Anopheles will take from 12 to 16 days in summer weather—longer in cool weather.

(a) Q. *Can one tell the larvæ of Anopheles?*

A. Yes. The Anopheles larva lies at the top of the water and parallel to it, for all the world like a basking pike. The larvæ of other mosquitoes hang from the top, head downward. If the latter are touched, they will always dive. If the Anopheles larva is touched, while it may dive it will generally "scoot" backwards along the top of the water. They are not a bit alike, and once seen no one will ever mistake one for the other.

Q. *Is it important to recognize the larvæ of Anopheles?*

A. Yes; it is far more important to recognize the larvæ of Anopheles than the mosquitoes themselves, because this enables us to find their breeding places and hence to destroy them.

(a) Q. *In what kind of places do Anopheles breed?*

A. They prefer to breed in *clean* water, in small, shallow, shady pools with grassy edges; if with grass growing in them, so much the better. A marshy piece of ground with many small pools, among bullrushes and sedge, is an ideal place. The grassy edges and quiet pools formed by obstruction on small streams are also favorite places, as are cattle tracks. They have no objection to running water unless running swiftly.

(a) Q. *Do they breed in such places only?*

A. They *occasionally* breed in almost any collection of water, unless it is very foul; shallow wells, water barrels, tin cans, etc., especially if they have leaves or grass in them or the green algæ—"frog moss." Generally, however, they avoid barrels, cans, and other artificial containers unless they have grass, moss, etc., in them.

(a) Q. *How long must a pool last to breed Anopheles?*

A. Since it takes usually about 14 days for the egg to produce the mosquito, if a collection of water dries up completely in less than 14 days, it is not apt to breed mosquitoes.

MALARIAL PARASITES IN MAN.

(a) Q. *When a mosquito injects malarial parasites into a man's blood what becomes of them?*

A. The parasites which she injects enter the red blood cells. They are then extremely small. They grow by feeding on the blood cells and get bigger and bigger. Then their edges become scalloped. Then they divide into a number of wedge-shaped pieces, meeting in the middle something like the slices of a pie. Then the blood cells break up and set the young parasites free, and each one of them starts off as a new parasite on its own account and tries to enter another red blood cell and repeat the process of its mother parasite.

(a) Q. *Into how many parts does a parasite divide?*

A. Into from eight to as many as 24 or 32, according to the kind, so they may increase very rapidly.

(b) Q. *Are there different kinds of parasites?*

A. Yes; there are at least three kinds, each of which produces a different form of malarial fever.

(b) Q. *How long does it take from the time the parasites enter a red blood cell until they divide into daughter parasites?*

A. It depends on the kind of parasite. One kind, the *tertian*, takes about 48 hours, or two days. Another, the *quartan*, 72 hours, or three days. A third, the *estivo-autumnal*, from about 24 to 48 hours. This last form is much less regular in its time than the other two; indeed, two different forms may be included under this name. It produces the worst kinds of malarial fever.

(b) Q. *What causes the chill and fever of the man with malaria?*

A. When the infected red blood cells break up they liberate not only the bunch of daughter parasites, but a small amount of poison which the parasites have formed, and, when a large number of them do this at the same time, this causes the chill and fever of the sick man, which occur just after the cells break down. It has been estimated that at least 150,000,000 of parasites must divide at the same time to liberate enough poison to produce a chill—generally many more than this.

(a) ? Q. *Do all parasites in the red blood cells divide into others, as you have described?*

A. No. Besides the sexless forms which divide and produce chills there are two other forms of malarial parasites in the blood cells. These are the male and female forms of the parasites. These do not seem to affect the health of the man in whose blood they exist, but it is by means of these that the mosquito becomes infected when she sucks them up.

(a) ? Q. *How does the mosquito become infected with malarial parasites?*

A. By biting a man who has these male and female parasites in his blood. If she sucks up both kinds—male and female—she may become infected.

(a) ? Q. *What takes place then?*

A. If the mosquito sucks up only sexless parasites with the blood she will not become infected, no matter how many she takes. If, however, the proper kind of mosquito takes up the male and female forms of the parasite they join together in her stomach and pass into her stomach wall, where they grow. After some time the bodies thus formed break and set free many young parasites, some of which finally find their way to the mouth of the mosquito. There the parasites are mixed with her saliva and are injected into a man when she bites him; then they enter the blood cells and start their life all over again.

(a) ? Q. *How long does this change take?*

A. From 7 to 14 days in the summer. It takes longer in cool weather than in hot.

(a) ? Q. *Is the mosquito dangerous to man until this change is completed?*

A. No. Until the parasites reach her saliva the mosquito cannot inject them into the person she bites. She is not dangerous, even if she has bitten a man with malarial fever, until the time necessary for this to happen has passed.

(a) Q. *Do the parasites growing in the mosquito make her sick, as they do a man in whom they grow?*

A. No. The mosquito seems to be as well as ever.

SECTION II.—PREVENTION OF MALARIA.

(a) Q. *Can malarial fever be controlled or prevented?*

A. Yes.[1]

[1] The control of malarial fever is a very different problem from its elimination or getting completely rid of it. The methods of work necessary to do this are simple, but to carry them out may well be beyond the economic limit allowable. To control it, however, that is to so lessen its amount that it does little injury in a community, is much oftener possible. It is at last a question of economics.

(a) Q. *What can be done to lessen or get rid of it?*

A. There are several methods which can be used.

First. By getting rid of the Anopheles mosquitoes which carry it.

Second. By not letting these mosquitoes get to well people to bite them.

Third. By so treating men having malarial parasites in their blood that they will not infect the mosquitoes.

Fourth. By so protecting healthy people that even if they are bitten by infected mosquitoes they will not develop malarial fever.

FIRST METHOD—GETTING RID OF ANOPHELES.

(a) Q. *How do you get rid of Anopheles?*

A. By destroying their shelters and their breeding places.

(1) DESTRUCTION OF SHELTERS

(a) Q. *What do you mean by their shelters?*

A. Anopheles live mainly out of doors, and as they can not bear the hot sun they shelter themselves in the brush and high weeds all day and come out at dusk to feed.

(a) Q. *What should be done to these shelters or hiding places?*

A. All brush and high weeds near one's house should be cut down so that mosquitoes cannot shelter themselves close to it.

(a) Q. *What should be done with the brush about their breeding places?*

A. This should also be cut down.

(a) Q. *Why?*

A. First. So we can see the breeding places to destroy them.

Second. So the sun can get in and dry up some of the breeding places.

Third. The less brush left to shelter mosquitoes the better, for if they are exposed to the hot sun many of them die.

(2) DESTRUCTION OF BREEDING PLACES

(a) Q. *How do you destroy their breeding places?*

A. In two ways: (1) By draining or filling up the pools, marshes, etc., in which they breed. (2) By oiling such pools as we can not drain or fill.

(a) Q. *How does drainage or filling up pools prevent breeding?*

A. By leaving no water in which they can breed.

(a) Q. *How does oiling the pools prevent breeding?*

A. It kills the larvæ.

(a) Q. *How does it kill the larvæ?*

A. The oil forms a layer on the surface of the water. Now, the larvæ must have air to breathe even if they do live in the water, and they come to the top to get it, and as they cannot get through this layer of oil to get air they die. Try it on a water barrel with wiggle-tails and see.

(b) Q. *How often should this oiling be done?*

A. Once in 12 or even 14 days would be often enough, but it is best done once a week on the same day of the week, so that it will not be forgotten. Use enough oil (coal oil or kerosene) to form a layer all over the surface, so that you can see it.

(a) Q. *Can all pools be oiled advantageously?*

A. No. If there be much grass in the pool the oil will not form a layer all over it. If the pool be large, that is a pond, the wind will blow the oil over to one side so that the surface on the other side is not covered. On large pools and grassy pools oil can not be depended on.

(a) Q. *Is there any other way besides oiling in which the water of pools, ditches, etc., can be made unfit for breeding Anopheles?*

A. Almost anything that makes the water foul and bad smelling will prevent Anopheles breeding in it, such as soapsuds, dyestuff, gas tar, refuse from mills, etc.

(a) Q. *What of water in barrels, drinking troughs, cans, etc.?*

A. Where water is often disturbed, as in chicken and horse troughs, Anopheles are not found or very rarely found; nor are they commonly found in barrels or in artificial containers of any kind, but they are sometimes, and if the water is not needed it is best to turn it out or oil it, or even put in a large amount of salt, as it *may* breed Anopheles, and *will* breed other mosquitoes, which are a nuisance even if they do not give one malaria.

(a) Q. *Have Anopheles larvæ other enemies besides man?*

A. Yes. The "top minnows" that are so abundant in some of our small, sluggish streams eat large numbers of them. In places where these minnows can get at them Anopheles larvæ are rarely found. Where there is grass or brush in the water frequently the fish can not get to the larvæ. These "top minnows" are our most efficient allies in our fight against these mosquitoes. Big fish are of little value—indeed, do harm by eating the minnows.[1]

SECOND METHOD—PREVENTING ACCESS OF ANOPHELES TO WELL PEOPLE

(a) Q. *How do we prevent Anopheles mosquitoes getting to healthy people to bite them?*

A. (1) By screening the house. (2) By mosquito bars.

(a) ? Q. *How should a house be screened against Anopheles?*

A. The screen should be No. 16 wire or No. 14 painted over to lessen the size of the mesh. All windows should be screened and all doors, if they are left open after dusk. All holes of all kinds by which mosquitoes can enter the house should be screened or closed, including the chimney. Screen doors should open outward. People should stay indoors after dusk, where mosquitoes can not reach them. Anopheles rarely enter a house in broad daylight. Screens with holes in them, or that do not fit tight, may do harm rather than good and be "mosquito traps."

(a) ? Q. *How may such screens do harm?*

A. Because Anopheles mosquitoes try to *enter* a house all night long and thus have time to find the smallest opening in the screening. They try to *leave* the house at first light, and if they cannot find the way out before broad daylight they are trapped in the house and hide in dark places, closets, under the bed, etc., and thus accumulate in the house.

(a) Q. *How should mosquito bars be used?*

A. They should be of fine bobbinet, with no holes in them and *with no slit up the side.* They should not go over either the head or the foot piece of the bedstead at night, but be tucked under the mattress all around and never allowed to hang down to the floor. They give some protection, but far less than good screening.[2]

THIRD METHOD—PREVENTING INFECTION OF MOSQUITOES

(a) ? Q. *How can we treat men with malarial parasites in their blood so that they will not infect mosquitoes?*

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[1] In this first method may also be noted the killing of Anopheles in dwelling houses. Sometimes after feeding at night Anopheles remain in the house, hiding in dark places. These are almost sure to again bite the people living in the house and are therefore much more dangerous than the same number out of doors. They may be killed with a "fly-swatter" or, if on the ceiling, by holding under them a small amount of coal oil in the top of a blacking box or yeast-powder can, into which they will drop. The can is to be nailed to the end of a long stick—a broom handle. Practice is required to find the mosquitoes. They look like little splinters on the wall and ceiling, but with practice this method can be made useful.

[2] How to screen houses against mosquitoes may be found in reprints of the United States Public Health Service, No. 170, Feb. 27, 1914, and No. 180, April 10, 1914.

A. In two ways: (1) By treating everyone who has these parasites in his blood until he is *cured* completely, not just partly well, to relapse later. This is the doctor's business. (2) By keeping these people in a screened house, or at least under a mosquito bar at night, as long as they have these parasites in their blood.

(a) ? Q. *Do people have parasites in their blood only when they have malarial fever?*

A. No. A man may have parasites in his blood and be infective to mosquitoes which bite him and yet show no signs of sickness. People are apt to have parasites in their blood for some time—days, weeks, or even months—after an attack of malarial fever.

(b) Q. *How do you explain that?*

A. (1) It takes a large number of parasites to make enough poison to produce fever, the number differing for different people, and one may have many parasites and yet not enough to produce fever. (2) The sexless parasites which divide are the only ones which produce fever, and there may be only a moderate number of these in one's blood and yet enough male and female forms to infect mosquitoes. These last, you know, are the only forms which do infect mosquitoes.

(b) Q. *What are the people called who are well and yet are infective to mosquitoes?*

A. They are called "carriers," and spread malaria in a community just as a sick man does.[1]

FOURTH METHOD—IMMUNIZING PEOPLE AGAINST MALARIAL FEVER

(a) Q. *How can we protect the healthy men so that even if they are bitten by infected mosquitoes they will not develop malarial fever?*

A. By the use of quinine.

(a) Q. *How is this done?*

A. If quinine is taken by any one in small doses during the malarial season it will generally prevent him from having malarial fever.

(a) Q. *How much must be taken?*

A. Generally in the United States 4 to 5 grains every day will be enough. Where the fever is bad as much as 7½ grains may be necessary, but even 2½ or 3 grains a day will prevent a great many fevers. It is best taken after meals in one dose or in divided doses.

(a) Q. *Must the quinine be taken every day?*

A. No. It can be taken in larger doses, as 8 grains twice a week, or even every five days. The first plan we think is the best.

(a) Q. *Does the quinine taken in this way injure those who take it?*

A. No. It has been taken thus by many people for a number of years, and none are known to have been injured by it.

(a) Q. *Does it make the people who take it feel badly?*

A. There are a few people whom even a very small dose of quinine makes feel badly, but generally it does not. There are very few people who cannot take enough to prevent malarial fever. Sometimes when quinine makes one feel badly at first the bad feeling will disappear if he continues to take it.

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[1] There seems to be a field for especially useful work on this line in the Temperate Zone among the "carriers" and people with latent malaria during the winter when there are no active Anopheles. This method has been recently utilized (by Bass) in Bolivar County, Miss., and marked success reported. It had been previously used, and successfully, in several places in the Tropics, first by Koch at Stephansort.

It is, however, much more applicable to a temperate climate in which during the winter season there is no flight of Anopheles. If the "seed parasites" in the human carriers are destroyed during this season, the malaria parasite is eliminated from the community and malaria will, of course, disappear, unless introduced from elsewhere. The parasite has not been found to hibernate in the mosquito in middle Mississippi.

(a) Q. *What is the dose for children?*

A. About one-half as much as for grown people; less for small children.

(a) Q. *What is the best preparation for children?*

A. The tannate of quinine is much less bitter than the other preparations. Made up into chocolates it is not especially disagreeable to take. It is also less apt to make grown people feel badly than other preparations.

(a) Q. *What is the dose of the tannate of quinine?*

A. About two and one-half times as much as of the ordinary kind—the sulphate.

(a) ? Q. *Do people prevented from developing the fever by these small doses of quinine ever have parasites in their blood?*

A. Yes. Unfortunately sometimes they do. To what extent this occurs and to what extent the quinine prevents the parasites from developing in the blood is not yet determined.[1]

(b) Q. *Are all people not protected by quinine liable to develop malarial fever when bitten by an infected mosquito?*

A. No. Some men seem to be naturally *insusceptible* to malaria. They are probably very few. In other men the having had a number of attacks of malaria produces an insusceptibility, or at least a lowered susceptibility, to the disease, and they do not under ordinary circumstances develop it. We frequently find in a malarial country families in which the children are having fever, while the old people are not. They have had many attacks in past years, and are now not susceptible to malaria. Sometimes a severe accident or a spell of sickness may render them susceptible again.

(b) Q. *Is malarial fever liable to relapse?*

A. Yes. Untreated, or imperfectly treated, it is almost sure to relapse, and to relapse several or even many times. The infection frequently lasts over from one season to another, the man being well for months between the attacks. It has been known to relapse after two years' interval. Many of the attacks of fever in a malarial country are relapses and not new infections. All those that occur in the winter and up to June or July, are probably relapses.

TEN YEARS OF DRAINAGE IN NORTH CAROLINA

By GEO. R. BOYD, Senior Drainage Engineer, U. S. Department of Agriculture

The natural fertility and richness of the swamp and overflowed lands of North Carolina have long been a matter of common knowledge. The first settlers, realizing that good drainage was of prime importance, took in and cultivated only those lands which either had good natural drainage or could be easily drained artificially. The swamp and wet lands were thus left in timber, and were considered to be almost worthless until only a few years ago when lumber became so high in price that these swamps were valuable on account of the timber which grew upon them. When the timber had been removed, these swamps again were held to be of little or no value. As a matter of fact, they were an injury and a liability to the community rather than an asset, for they were breeding and harboring places for the Anopheles mosquito, which is responsible for what was once the great plague of the South, malaria. Although the richness of these swamp lands was appreciated, and their unhealthfulness was recognized, it was not possible for many reasons to undertake their reclamation on a large scale until 1909. In that

[1] Reprint No. 175, United States Public Health Service, gives a short account of the "quinine prophylaxis" of malaria.

year the State Drainage Law was passed which furnished a means for the coöperation of many landowners in draining these swamps and provided means of financing the drainage work so that the landowners could pay for the work through a period of years after the drainage had been secured. Beginning with that year, each year has seen an increasingly large number of drainage districts organized until at present there are something like two hundred districts in the various stages of organization. The Census Bureau for 1920 has been collecting information concerning drainage work throughout the United States and has issued complete preliminary reports on such work in North Carolina, so that it is now possible to determine, in a measure, just what has been accomplished during the past ten years.

The following table has been compiled from various reports issued by the Census Bureau, and includes all drainage districts which had been legally established up to 1920. In some of these districts, the construction work was completed some time ago, while in others construction may not have been started as yet.

It will be seen from this table that in the entire State there are, in round numbers, 550,000 acres of land which is almost two per cent of the area of the State included in regularly organized drainage districts; and that in Eastern North Carolina 475,000 acres is organized to secure better drainage. Of these 475,000 acres, 150,000 are improved farm lands—*i. e.*, they were in cultivation when the drainage district was organized—and 325,000 acres were either in timber or cut-over timber, or were uncultivated for some other reason, when the district was established. Putting these figures a little more concretely, it may be said that over the entire State an area slightly larger than Pender County has been organized into drainage districts, and of this acreage an area four and one-half times as large as New Hanover County is in process of being reclaimed and put into cultivation. Under ordinary conditions, the clearing up of these wet, cut-over lands goes on at the same time that the drainage system is being constructed, and since a large part of the work included in this table has been completed for some years, it is not unreasonable to conclude that a swamp area twice as large as New Hanover County has already been redeemed, and is now producing crops.

Of course the draining of even a large body of land is of little benefit to any one unless that land be capable of producing something. Fortunately, there is no question about the fertility of these lands although, naturally, some are better than others. They are universally recognized to be the richest lands in the State—and that is saying enough, for yields of many different crops have been reported in this State which have not been exceeded anywhere. In general, these drained lands will grow any kind of a crop—corn, cotton, grain, hay, potatoes, or truck crops. Some are especially adapted to specialized agriculture while others are more valuable for general and varied farming. Special crops are grown in some sections, such as strawberries in Pender and Columbus counties, where drained lands are selling around $1,000 per acre. Early Irish potatoes, followed by corn or cotton, are raised extensively in other sections. One tract of reclaimed swamp land in Beaufort County, containing about 100 acres, was rented for this year for potato growing at $100 per acre. Some of these swamp lands have been recently put in tobacco with excellent results. As a general thing, however, they are used for general farm crops, and probably more land is put in corn than in any other crop.

While it is impossible to give any figures covering the increased value of these reclaimed lands, it cannot be doubted that the total sum which has thus been added to the resources of the State is enormous. Individual instances by the hundreds could be given of increased values of land resulting from these drainage improvements, for, as far as the writer knows, every one of

SUMMARY OF PRELIMINARY DRAINAGE CENSUS REPORTS—NORTH CAROLINA, 1920*

Counties	Acreage in Organized Drainage Districts				Total Acreage in Counties	Per Cent of Acreage in Drainage Districts	Total Cost	Cost Per Acre, All Lands in Districts
	Improved Farm Lands	Timbered and Cut-over Land	Other Unimproved Land	Total				
Eastern North Carolina—								
Beaufort	24,155	24,017	11,457	59,629	537,600	11.1	$ 304,250	$ 5.10
Bladen, Columbus, Cumberland, Harnett, New Hanover, Pender, and Robeson	44,193	61,905	4,974	111,072	3,320,320	3.3	645,500	5.82
Camden Carteret, Chowan, Currituck, Greene, Jones, Lenoir, Pamlico, Tyrrell, Perquimans, Wayne, and Wilson	34,853	58,857	33,473	127,183	3,139,200	4.0	595,648	4.68
Edgecombe	4,857			4,857	325,760	1.5	30,000	6.18
Hyde	35,024	24,375	69,130	128,529	394,880	32.5	800,272	6.22
Pitt	1,760	450	3,990	6,200	401,280	1.5	77,600	12.51
Washington	4,969	29,695	3,780	38,444	209,280	18.4	334,352	8.70
Totals	149,811	199,299	126,804	475,914	8,328,320	5.7	2,787,622	5.85
Western North Carolina—								
Alexander, Burke, Caldwell, Cleveland, Davidson, Forsyth, and McDowell	17,557	21	4,988	22,566	2,033,920	1.1	173,900	7.70
Cabarrus	3,261	58	460	3,779	249,600	1.5	53,894	14.26
Catawba	2,902	133	167	3,202	261,120	1.2	99,250	31.00
Gaston	2,784	120	293	3,197	232,320	1.4	44,000	13.76
Iredell	7,509	591	579	8,679	376,320	2.3	183,725	21.18
Lincoln	955	70	575	1,600	191,360	0.9	37,000	23.10
Mecklenburg	14,367	476	2,381	17,224	382,080	4.5	115,101	6.68
Rowan	5,152	959	916	7,027	312,960	2.2	129,026	18.38
Totals	54,487	2,428	10,359	67,274	4,039,680	1.4	835,896	13.55
Other counties					18,825,600			
Totals for the State	204,298	201,727	137,163	543,188	31,193,600	1.7	3,623,518	6.67

*The figures in this table are taken from the last United States Census and the total acreage given as drained is somewhat less than the area at the present time.

these drainage districts that has had competent advisers has been successful in a large degree. To show something of the way in which these lands are being developed after drainage, and of the results that have been secured, brief extracts are given from some of the reports presented to the State Drainage Association in 1916:

BEAUFORT COUNTY.

Broad Creek District.

"The work in this district is practically complete. There is now between five and six thousand acres of new land to plant to corn this year, and there will probably be a larger amount cut down during this spring and planted next year; I believe that we will have at least twelve thousand acres of new land planted to corn next year."

Pantego District.

"I am sure that the land in that district, taken as a whole, has increased in value over 400 per cent. I know that that is a conservative estimate. There is not in that district an acre of cleared land that can be bought for less than $100. There is not an acre of woods land that can be bought for less than $30, and I can easily remember when that land was valued for taxation at 50 cents per acre, and we had not more than half of the exact acreage on the tax books."

NEW HANOVER COUNTY.

New Hanover District No. 1.

"This district has been completed about twelve months. Not only in an agricultural way are they reaping great rewards, but it has developed into a suburban territory. Homes are being built upon it. Already thirteen have gone up, each of which represents an expenditure of from two to four thousand dollars."

ROBESON COUNTY.

Back Swamp and Jacobs Swamp.

"We have had our district completed about three years. It has given very satisfactory results, and a good deal of land has been cleared in the district. Some of the land which was utterly worthless sold for $40 to $50 per acre. Before draining it was worth possibly $5 per acre. We paid our first assessment last year and had very little trouble in raising the money."

CRAVEN COUNTY.

"A large tract of land had been drained by private enterprise. I asked the value of that land and was told that it could not be bought for $100 per acre. Other undrained land nearby was selling for $10 per acre. This land, when drained, has such a deep soil that it is exceedingly productive for any number of years."

CABARRUS COUNTY.

Big Cold Water District.

"As much as seventy bushels of corn per acre has been raised on the drained land in this district without fertilizer, and an enormous crop of corn was raised on the land in this district in 1915. From the health standpoint the drainage has been a remarkable success. Malaria and chills have decreased, so the doctors say, 75 per cent. From an agricultural standpoint the drainage of this district has been a success, and the ditch has maintained itself as well as those who had favored the project had hoped in the beginning."

The Census reports show that the work in the State has cost $3,623,518, of which amount eastern North Carolina has paid $2,787,622. The State drainage law provides for the issuance of bonds covering the cost of the drainage

work, and these bonds are paid off in ten equal installments beginning three years after the date of issue. Thus the landowners have three years time in which to put their lands in shape to take advantage of the improved drainage conditions before they have to pay anything toward the cost of the work, and after that date they pay one-tenth of the cost of the work each year for ten years. Interest on these deferred payments must be paid. It is not too much to say that this work could never have been done without some such system of deferred payments, for very few of the landowners in any of these districts have had the money on hand to pay their part of the costs of the drainage work when it was done. The framers of the drainage law were so careful of the rights of both the landowners and the bond buyers that the method of financing provided by the law has proven to be very satisfactory to both. Under normal conditions there is a good market for such drainage bonds, and so far there has been very little trouble in collecting the funds necessary to pay them off, when they fall due.

A column showing the average cost per acre of the drainage works is found in the table. The figures given, although surprisingly uniform, represent only in a very general way the cost of the work to the landowners. In most of the counties given there are several drainage districts, and as the cost in any one district depends on the conditions in that district there is, no doubt, a considerable difference in the cost per acre in the various districts in any one county. Further, the costs in any one district are divided among the landowners in proportion to the benefit each receives, so that the costs to the landowner will differ materially from the average costs for the district as a whole. And, finally, in common with everything else, the costs of drainage construction work have increased a great deal during the past three years, so it is probable that the average costs shown are well below any average costs which could be obtained for similar districts at the present time. These figures are included in the table merely to bring out the fact that this drainage work has not been an expensive undertaking. Considered in the light of the profits shown by the district reports for 1916 which were quoted above, the average acreage cost for the State of $6.67, and for Eastern North Carolina of $5.85, seem insignificant indeed.

To sum up briefly what has been accomplished during the past ten years, it may be said that over a half-million acres of land have been included in drainage districts; that 350,000 acres of land which is very fertile and adapted to the growing of almost any crop, but which has hitherto been too wet for cultivation, has been or is being put into cultivation; and that a system of finance has been built up under the State Drainage Law whereby the costs of this work—amounting to more than $3,500,000—are being paid off by the landowners without hardship.

Although much has been accomplished during the past ten years, the reclamation of the swamp and overflowed lands of North Carolina can hardly be said to have started as yet. So much remains to be done that the little which has been done is valuable chiefly as an example or illustration of the benefits which may be expected from improved drainage. It has been said that there are over four million acres of swamp and overflowed lands in this State. Deducting from this amount the half-million acres already in drainage districts (which is not strictly correct as some of this half-million acres is undoubtedly high land), there still remains three and one-half million acres to be drained. To one who is familiar with the intensive and extensive agriculture as now practiced in Indiana, Illinois, and Iowa, on lands which thirty years ago needed drainage as badly as do the swamp lands of eastern North Carolina today, the vast amount of wet land which can be seen from the windows of any railroad train crossing Eastern North Carolina represents

a waste and a neglected opportunity which is little less than appalling. Unquestionably there is a need for this land, a need for the produce which it could furnish, and a need for the homes which it might support.

As has been said, this land is adapted by nature for the growing of all kinds of crops and has produced bountiful crops whenever given a chance. In addition to the wonderfully rich soil, and the long growing season, the advantage of location which these lands have with reference to markets makes them particularly attractive to the farmer. Since, under normal conditions, the local price for any farm product is the price of that product at the export shipping point, less the cost of getting the product to the export point, it follows that North Carolina farm products must always be considerably higher than the same products when marketed in States farther from the export centers. The writer has compiled the following table from the Monthly Crop Reports of the United States Bureau of Markets, showing the selling price of corn, per bushel, on the 1st of December each year since 1913 in North Carolina and in Iowa, and the average price throughout the United States:

	1913	1914	1915	1916	1917	1918	1919
North Carolina	$ 0.88	$ 0.86	$ 0.77	$ 1.10	$ 1.70	$ 1.77	$ 1.85
Iowa	.60	.55	.51	.80	1.08	1.22	1.20
Average for United States	.69	.64	.57	.90	1.28	1.36	1.35

These are the prices which the Bureau of Markets says were received by the farmers. They show that a bushel of corn was worth from 28 to 65 cents more, per bushel, in North Carolina than in Iowa, which is one of the premier corn-growing States. As this difference is based on the cost of transportation, it increases whenever freight rates increase; thus the margin increased markedly in 1917, and as the freight rates have been still further increased this year, it is probable that the difference in North Carolina's favor will be still greater in 1920. The same facts are true of the other staple crops, and this rule will continue to hold good until the railroads cease to charge for hauling freight. A market, then, at a price considerably above the average price for farm products in the United States, can be counted upon with certainty when considering the possibilities of draining these swamp lands.

In addition to the work which has been done by these various drainage districts, it is felt that two other lines of drainage improvement should be emphasized. One of these is complete drainage such as is secured by lateral open ditches or tile drains. In too many instances landowners, both in drainage districts and outside of them, are content when the surface water is removed from their lands, whereas they should be satisfied with nothing less than complete drainage. As between open lateral ditches and tile drains, tile drains are much to be preferred. The advantages of complete drainage have been well summed up by Prof. Newman, as follows:

"Drainage removes surplus water, deepens the soil, prevents too great dilution of plant food; improves the quality and texture of soils by making them porous and friable; admits air with its food-making and purifying oxygen; enables plants to stand drouth better, to send their roots deeper; it warms the soil and extends the period of plant growth; it checks winter killing of crops; crops start growing earlier in the spring and continue longer in growth in the fall; it aids in the healthful development of beneficial bacteria; seeds will germinate better in drained land; crops rot less and are more easily gathered from drained land than from land in need of drainage."

The need of tile drainage often is not recognized as such by the owner. It is probably safe to say that 60 per cent of the lands in Eastern North

Carolina could be improved by complete drainage. The need for drainage is indicated by water standing on the land after rains, by the cracking of the surface when it dries, by clods and harsh soil texture when plowed, by the growth of plants commonly found in wet places, and by the water table being near the surface of the ground. After a wet season, irregular areas in fields often show their need for drainage by slow growth and poor color of the growing crops, because the plant food has been washed away. Lands showing any of the above indications of an excess of water, though they be shown for only a short time, are in need of proper drainage. This work may be done by either individuals or by regularly organized drainage districts.

Another field of drainage reclamation which has been almost entirely neglected in North Carolina, is found in the abandoned rice fields and in the marshes along the coast. While these lands must, in general, be reclaimed by means of pumps, there is no doubt that many of them are very fertile and can be successfully drained in this way. While it is probable that the costs of reclaiming these lands will be somewhat higher than that of the swamps, which can be drained by gravity, at the same time it is felt that the development of some of them, at least, cannot be much longer delayed.

REPORT ON A PRELIMINARY EXAMINATION OF LITTLE RIVER DRAINAGE DISTRICT, PASQUOTANK COUNTY, N. C.*

BY F. O. BARTEL, Drainage Engineer
Prepared under the direction of S. H. McCRORY, Chief, Division of Agricultural Engineering, 1921

INTRODUCTION

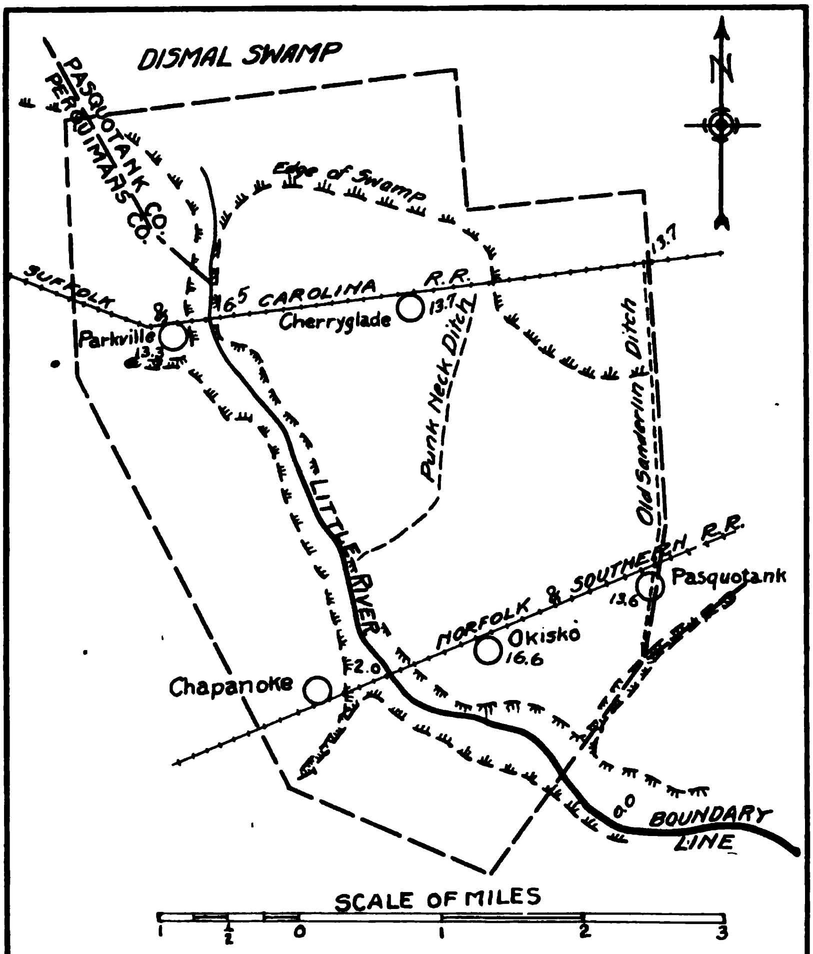
At the annual convention of the North Carolina Drainage Association held at Elizabeth City, April 12-14, 1921, Mr. T. S. Ownley, a prominent landowner of Pasquotank County, requested that an engineer from this office be sent to make a preliminary investigation of Little River, which forms the boundary line between Pasquotank and Perquimans counties, North Carolina, although such a report on this territory had been made by drainage investigations in 1909. In response to Mr. Ownley's request, Mr. H. M. Lynde, senior drainage engineer, visited the territory on May 11 and 12, 1921, but died before a report on his examination had been prepared. A third examination was then made on August 16, 1921, and the following report prepared by the writer.

The examination consisted in walking and driving about the district, gathering data and interviewing the landowners. The writer is indebted to Messrs. T. S. Ownley, H. E. Ownley, George Bright, and Wesley Foreman for information regarding conditions, and to the Norfolk Southern Railroad for elevations along its roadbed. There are about 40 landowners interested in the proposed improvement.

GEOGRAPHICAL LOCATION AND AREA

The proposed district comprises an area of about 11,000 acres, as shown on the accompanying map. It is bounded on the north by the Dismal Swamp, on the east by the Foreman plantation, and on the west by Parkville Drain-

* U. S. Department of Agriculture in coöperation with N. C. Department of Agriculture.



LITTLE RIVER DRAINAGE DISTRICT
PASQUOTANK COUNTY, N. C.

FIG. 1.

EM~1-7-22.

age District. Little River empties into Albemarle Sound about 13 miles below the south boundary of the district. There are no towns of more than 100 inhabitants in the district, but Elizabeth City, with a population of around 10,000, lies nine miles to the east. The district is crossed by two branches of the Norfolk Southern Railroad.

NATURAL SURFACE CONDITIONS

The run of Little River lies in a swamp bottom from about 600 to 2,000 feet wide, well defined at the lower end of the district, but hardly to be distinguished from the surrounding land above the Suffolk and Carolina Railroad. The bottom is overgrown with cypress, gum, maple, and other marsh timber, and is not more than one or two feet higher than the bottom of the stream channel. The lands back from the bottom belong to the well known Portsmouth and Norfolk series, which constitute the bulk of the agricultural land of eastern North Carolina. From what could be learned of that portion of the Dismal Swamp included in the tentative boundary lines of the district, as shown on the map, it is believed that this land has a clay subsoil and, when drained, would correspond somewhat to the Portsmouth soil that bounds it, thus differing greatly from the poor "Juniper Land" that usually lies along the edges of the Great Dismal Swamp.

It is estimated that fully 75 per cent of the land included in the district is cleared and under cultivation.

NATURAL DRAINAGE CONDITIONS

All the water that falls in the district drains to Little River. Several canals have been cut to drain the land back from the river, the most prominent being the Old Sanderlin Ditch and the Punk Neck Ditch. These are hand dug canals, shallow and poorly graded, and do little toward improving conditions further back than three-fourths of a mile from the run of the swamp. Their lack of capacity is shown by the fact that it has been found necessary to construct low dams at their upper ends to keep back the water from the Dismal Swamp, which is now taken down a small ditch along the railroad to Little River, near Parkville. The grade of this ditch and its outlet are poor and, as a consequence, the large volume of water coming down from the swamp in times of heavy rain often accumulates to a depth of a foot or more on the north side of the railroad, finds its way through culverts under the roadbed and drowns out crops on the land to the south. The land in the swamp is higher than that in the district, and near its southern extremity has appreciably more slope than toward its interior, resulting in the water from a considerable area of the swamp coming down on the district. The removal of this swamp water is one of the principal ends to be accomplished by a drainage system.

Surface elevations range from about 14 feet above sea level, in the swamp, to tide water level at the lower end of the district.

The topography is such that, except for some of the higher lands immediately adjacent to the runs, no successful drainage can be accomplished without coöperation; the need of organizing a drainage district is plainly shown. The difference in the value of crops between ordinarily dry and wet seasons, due to present poor drainage, shows that a satisfactory drainage system would pay for itself in a few years.

IMPROVEMENTS REQUIRED

The drainage of the tract appears to present no particular difficulties. The solution of the problem consists in the improvement of Little River as an outlet channel for a number of lateral ditches spaced approximately one mile apart. With this as a basis, the whole area can then be completely drained by the construction of ordinary farm drains.

It is the desire of the writer to emphasize the importance of a sufficient number of deep lateral drains. Experience has shown that in country having a topography similar to this, the land is seldom successfully drained further back than about three-fourths of a mile from the outlet channel by means of ordinary hand cut ditches.

The main collecting ditch will begin about one-half mile below the lower end of the district, and will follow in the general direction of Little River. keeping as near the center of the swamp and on as straight a course and with as easy bonds as possible. The present run of the river should be considered in laying off this main. At the upper end of the district, it will turn to the east, running parallel to the Suffolk and Carolina R. R. at a distance of one mile. There will be approximately nine miles of this canal draining a watershed of about 25 square miles. Assuming a run-off factor of one-half inch over the watershed in 24 hours, and a fall of 1.3 feet per mile, this will require a channel having a bottom width of 24 feet at the lower end of the district, narrowing to 10 feet at the Suffolk and Carolina Railroad, and to six feet at the upper end, with side slopes of one-half horizontal to one vertical. The lower six miles will average about six and one-half feet in depth, and the upper three miles about eight feet, which will require the removal of about 210,760 cubic yards of material. In addition, the run of the swamp for about one mile below the lower end should be cleared of fallen trees, logs, and other obstructions. The only practical means of cutting this canal will be with a floating dredge.

It is desirable that no farm in the district should have to go more than one-half mile to secure a good outlet; this means that the lateral outlet canals should not be over one mile apart, preferably closer than this. The best location for these canals can only be determined after a survey has been made. They should, in general, run parallel to each other and be so located as to subdivide the land to the best advantage, drainage, however, being given first consideration.

The lateral canals may be cut by either a floating dredge or by a land walking dredge. In the former case, a minimum bottom width of six feet must be used, which for a canal eight feet deep with side slopes of ½ : 1 means an excavation of 15,650 cubic yards per mile. Using a land dredge a smaller bottom width may be cut. With a four foot bottom width, which is ample, and the same depth and slopes as above, about 12,500 cubic yards per mile must be removed.

The cost of excavation with a land machine is greater, as a rule, than with a floating dredge. Estimating the former at 15 cents per cubic yard and the latter at 12 cents, the cost of constructing the laterals figures about $1,875 per mile by either method. The advantage in regard to the cost of maintenance will be with the smaller ditch, although this may be offset by a lower bid per yard on a contract requiring but one type of machine. About 11 miles of laterals will be needed.

Estimating the cost of excavation of the main at 12 cents per cubic yard we have

210,760 cubic yards at 12c.	$25,291	cost of main
11 miles of laterals at $1,875 per mile	20,600	cost of lateral
or a total cost of excavation of	$45,891	
Adding 10% for engineering, legal, administrative and miscellaneous expenses	4,589	
we have a total estimated cost of	$50,480	

for the project. As there are about 11,000 acres in the district, this will be an average cost of $4.60 per acre.

SURVEY

For the purpose of obtaining data concerning the general elevation, surface slopes, and other physical features of the district, necessary in order to lay out a satisfactory drainage system, an extended survey will be necessary. A level or transit with stadia hairs and compass attached would be a convenient instrument for most of the work.

All elevations should be referred to sea level as a datum. Level lines should be run along all the roads and railroads in the district and as many cross lines as may be necessary to obtain a thorough knowledge of the topography. All natural runs should be meandered and elevations taken along their courses. Such a survey would constitute what is known as a preliminary survey and require about one month's time for one party.

The final and complete survey would require that all ditches be staked out on the ground by setting stakes 100 feet apart, and that land lines be shown on the map.

ORGANIZATION OF DRAINAGE DISTRICTS

If the landowners decide to undertake the work, it is recommended that a drainage district be organized under the State law. To organize a district, a petition must be signed by a majority of the resident landowners, or the owners of three-fifths of the land in the district, and presented to the clerk of court. After the district is organized, a survey made, and engineers' report handed in showing the cost of the work, viewers are sent out to appraise damages and divide the land into five classes according to the amount of benefit it will receive. The drainage commissioners (elected by the landowners) then float a bond issue, the contract is let, and the ditches constructed.

Drainage bonds are issued in an amount covering the total cost of improvement plus a sum sufficient to pay interest on the bonds for three years following the date of issue. The bonds bear interest at the rate of six per cent annually, and are paid in ten equal installments. The first installment of principle matures in three years, and one installment thereafter for nine more years.

CONCLUSIONS

Outlet drainage can be secured for the lands discussed in this report for from $4 to $5 per acre. The best and most economical arrangement of ditches cannot be determined until a drainage survey of the area is made. The agricultural value of the land, with the possible exception of the swamp, is known; the district is already well settled and cleared, and should prove profitable for immediate development.

In addition to its importance from a strictly agricultural standpoint, drainage will be of considerable value in the improvement of health conditions, and in benefiting the roads in the district, of which there are a considerable mileage.

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, DIRECTOR

ECONOMIC PAPER No. 53

WATER POWER SURVEY OF SURRY AND WILKES COUNTIES

BY

THORNDIKE SAVILLE, HYDRAULIC ENGINEER

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LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., March 20, 1922.

To His Excellency, CAMERON MORRISON,
Governor of North Carolina.

SIR:—There is herewith submitted manuscript on "A Water Power Survey of Surry and Wilkes Counties," which has been made in coöperation with the county commissioners of these two counties; and it is recommended that this report be published as Economic Paper No. 53 of the publications of the North Carolina Geological and Economic Survey.

This is the first of a series of reports that are being made on the water powers of the several counties of the State in coöperation with the boards of county commissioners.

Yours respectfully,

JOSEPH HYDE PRATT, *Director,*
North Carolina Geological and Economic Survey.

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PART II

PREFACE

The present report on a "Water Power Survey of Surry and Wilkes Counties" was prepared by the North Carolina Geological and Economic Survey in coöperation with the boards of county commissioners of the counties, and is the first of a series of such reports that the Survey hopes to be able to bring out covering the water power resources of each county of the State. The value of these reports has already been demonstrated by the use that has been made of the present report while in manuscript form. Plans for the development of several water powers described in the report have already been made.

The board of commissioners of Surry County consisted of Thomas Fawcett, Mount Airy; A. W. George, Elkin, and S. F. Shelton, Mount Airy, R. F. D., and the board of commissioners of Wilkes County were D. C. Sebastian, Hayes; D. V. Nichols, Purlear, and C. M. Caudill, Traphill.

JOSEPH HYDE PRATT, *Director,*
North Carolina Geological and Economic Survey.

PART I

WATER POWERS OF SURRY COUNTY

BY

THORNDIKE SAVILLE, HYDRAULIC ENGINEER

PART I

LIST OF MAPS AND DIAGRAMS

[ENCLOSED IN POCKET ATTACHED TO BACK COVER]

LIST OF TABLES

PART I

WATER POWER SURVEY OF SURRY COUNTY

By THORNDIKE SAVILLE, *Hydraulic Engineer*

INTRODUCTION

Location.—Surry County is the northernmost county in the State abutting on the eastern slope of the Blue Ridge. It is bounded on the north by Patrick County, Virginia, and on the east, south, and west respectively by Stokes, Yadkin, and Alleghany counties, North Carolina. Its elevation above sea level is generally high, varying from about 600 feet at Boyden on the Yadkin River near the southeast corner of the county to 3,609 feet at Fisher Peak on the Blue Ridge. A map of the county will be found in the pocket at end of report.

Climate.—The climate is that of the upper Piedmont region. At Mount Airy, the principal city, elevation 1,048, there is a mean annual rainfall of about 47 inches; the average, mean maximum, and mean minimum temperatures are 56, 68, and 44 degrees, respectively. The extremes of temperature range from a maximum of 103 to a minimum of —15 degrees Fahrenheit. The average date of the first and last killing frosts is October 17 and April 21, respectively. The climate is considerably more moderate in the southern part of the county, especially in the wide and fertile valley of the Yadkin.

Agriculture.—In the middle and southern parts of the county, especially in the river valleys, a great deal of fine tobacco is raised. On the uplands cotton and corn are the staple products. In the mountainous districts the county is famous for its fine fruit and vegetables, great quantities of apples, cabbage, etc., being shipped to market. Mount Airy is the greatest cabbage market south of New York.

Manufactures.—The furniture industry thrives at Mount Airy, due to the excellent timber still remaining in the county. The chief industry is the quarrying and cutting of granite, the Mount Airy granite being known and used all over the United States for building and monumental stone. There are a number of cotton mills and gins throughout the county.

Transportation.—The Southern Railroad branch line between Winston-Salem and North Wilkesboro parallels the southern edge of the county along the Yadkin River. The Atlantic and Yadkin Railroad from Greensboro, runs from Pilot Mountain to Mount Airy in Surry County. These two railroads serve a considerable territory devoted to the pursuits noted above, and are not far distant from the streams

where good water-power sites are available. Good roads are being rapidly constructed to bring the more remote districts into communication with the railroad and manufacturing centers.

WATER POWERS

The principal streams of the region, in order of importance, are the Yadkin, Ararat, Fishers, and Mitchell rivers. Elkin River cuts across the southeastern edge of the county for a few miles. The natural flow of the streams in the northeastern section of this county is as constant as in any other district in the State—the rainfall being distributed over the year, and the mountain sides having a strong second growth, which retards flood discharges, while the rocky character of the upland regions gives a large total yield of the rainfall falling upon the surface.

There are no great water powers in excess of 5,000 horsepower available in the region other than that at Bean Shoals, on the Yadkin. There are a number of excellent sites, however, where from 500 to 2,000 continuous primary horsepower may be developed, and this may, in some instances, be more than doubled by pondage, permitting a 10-hour or 12-hour utilization of flow. In nearly every instance these sites are located within five or ten miles of good railway facilities, and a hydroelectric plant on the streams may easily generate power to be transmitted a short distance to manufacturing plants located on the railroads.

In general, the valleys are narrow and no large storage is possible at dam sites. To develop the streams for maximum power will mean steam auxiliary or interconnection with some large station, such as might be constructed at Bean Shoals. At many sites, however, the continuous flow of the stream is sufficient to supply constant power up to from 500 to 2,000 horsepower.

Definitions relating to water powers.—The following definitions are given to enable the nontechnical reader to utilize this report.

Stream flow.—The amount of water flowing in the stream under given conditions, measured in cubic feet per second. One cubic foot equals 7½ gallons.

Cubic feet per second per square mile.—The amount of water in cubic feet per second flowing from each square mile of the drainage area under the given conditions.

Storage.—The amount of water in cubic feet, or other unit, which may be impounded behind a dam and used to supplement the flow of the stream during extended periods (several weeks) of low flow. The effect is to increase the amount of continuous flow at the dam site.

Pondage.—The amount of water in cubic feet or other unit which may be impounded behind a dam and used to collect the flow of the stream for a short period, usually from 12 to 14 hours, when the plant is not in use. It is a much smaller volume of water than that necessary for storage. The effect is to enable the plant to use in 10 or 12 hours the entire flow of the stream for 24 hours.

Gaging station.—A place on the river where occasional measurements of stream flow are made by means of an instrument known as a current meter. A pennant staff gage is usually installed at these places, which is graduated to read the height of the water surface in feet and tenths of a foot. By daily observations of the staff gage after measurements have been made by the current meter, the engineer is able to compute the amount of water flowing in the stream each day.

Flow of streams.—The average annual flow of the streams of the region may be taken as approximately 1.8 cubic feet per second per square mile of drainage area. The average minimum monthly flow during the dry season is between 0.7 and 1.2 second feet per square mile. The minimum flow for the highest six months in the year is about 1.2 second feet per square mile. The minimum daily flow in one year averages about 0.5 second feet per square mile.

Horsepower.—The horsepower which can be developed from a stream is dependent both upon the amount of water flowing and the height through which it may be made to fall by means of a dam or other device. A rough method for determining the horsepower available for use is to multiply the stream flow in cubic feet per second by the height of fall and divide by eleven. It is thus evident that while there may be a very high fall, the horsepower that can be developed is not large unless there is a considerable amount of water flowing.

Primary power.—The amount of power that can be developed on the average for twelve months in the year. It is usually a small percentage of the average power which can be generated by a stream if storage or auxiliary power is available.

Secondary power.—The amount of power that can be developed for periods shorter than the entire year, as for nine or ten months when the stream flow is not a minimum. To make up the deficiency due to low stream flow some sort of storage or auxiliary power is needed.

Profile.—A diagram which shows the relative elevation above some given place of points along a stream bed.

Cross section.—A diagram showing the position and elevation of the banks of a stream at a dam site with reference to the bed of the stream.

Topographic map.—A map or plan of a district showing by means of contour lines the elevation of different points in the district with reference to some established point. Such a map shows the relative elevations and location of ground above a dam site, and from it the amount of water to be impounded by the dam can be found and the area which it will flood back of the dam.

ARARAT RIVER

This is the largest of the streams of Surry County tributary to the Yadkin. It enters that river between Shoals and Siloam, and extends in a generally northern direction from its mouth to Mount Airy. The drainage area at the mouth is about 295 square miles. Above Mount

Airy it is improbable that sites exist for economically developing over 500 horsepower. A profile of the river bottom was run from the mouth to the bridge at Douglass Ford on the Pilot Mountain-Dobson road, a distance of about twelve miles. This is shown in Fig. 2. One or two possible dam sites exist below the Shoals bridge, but there is little fall available, large areas of valuable land would be flooded, and back water from the Yadkin would frequently interfere with plant operation.

The first practicable dam site is located about three miles above the mouth. There are here some shoals giving a fall of about eight feet. A profile of this section of the river, with cross section of dam site, is shown in Figs. 2 and 4.

Matthews Dam.—The first really excellent dam site is that at Matthews Dam, about one mile above the Shoals bridge at Harlan Ford, and five miles above the mouth of the river. At present there is a new timber crib dam here, eight feet high, which was used to run a grist mill not now in use. A cross section of this site is shown on Fig. 3, indicating the steep and high banks. It would be possible to construct a 72-foot dam, giving an 80-foot fall, impounding water back to Ararat Station on the Atlantic and Yadkin Railroad and giving excellent storage. It is estimated that about 4,000 24-hour horsepower, or 9,600 10-hour horsepower, could be constantly maintained without use of auxiliary power. The site is located near a good road and about 3 miles from Siloam Station of the Southern Railroad. It should be noted that if the Bean Shoals development on the Yadkin is ever made, backwater from this might occasionally handicap the Matthews Dam plant. The Bean Shoals development is at present a rather remote possibility, owing to the presence of the railroad, and in the event it is ever made, damages could be collected for any impairment of earlier developments. The Matthews mill-dam site is regarded as capable of the best and greatest power development on the Ararat River. It is readily accessible for construction, is near to good transportation facilities, and the back water above the dam will flood only a moderate amount of cultivable bottom lands. Its construction would eliminate development of all other dam sites on the Ararat described hereafter.

The third dam site, at station 305+43, is shown in cross section on Fig. 4, and is located at the horseshoe bend above Whitt Ford. It is located at the bottom of some shoals, giving a fall of about 5 feet. The hills on each side are rock and foundation conditions good.

The fourth site is at station 205+20, and is one of the best on the river from a construction point of view.

Hiatt's Dam.—The fifth site is known as Hiatt's dam site. There has been much agitation in Pilot Mountain to develop here an installation to furnish power for the town. For this reason a small contour map of the area above the dam site was made and is shown in Fig. 5. This site is so high up on the river that a dam would be limited to about

20 feet high. Otherwise the railroad would be flooded above Ararat Station. Relocation is out of the question. Not more than 500 minimum 12-hour horsepower could be developed here without auxiliary power to carry the plant over periods of low water. It might be economical to develop for possibly 700 horsepower, which with pondage for 12 hours per day could probably be counted on during 10 months in the year. The site is not regarded as offering nearly so good a development as the next one below, at station 123+19.

With the maximum development at each dam site which will not interfere with the development of the next site up stream, and by development of all sites, 1,260 24-hour primary horsepower can be developed, whereas the maximum development at Matthews Dam would alone give 4,000 primary horsepower. It is evident that the latter development is by far the most satisfactory to make, both from the standpoint of cost and economy in operation. It is much to be hoped that the interests along the river will combine to develop this single power to their mutual advantage.

TABLE I.—POWER AVAILABLE AT DAM SITES ON SURRY COUNTY STREAMS

River	Location	Drainage Area, Tributary Square Miles	Maximum Fall in Feet	Minimum Power Without Storage	Horsepower Available with Storage		
					12 Months	6 Months	3 Months
Yadkin	Bean Shoals	1,300	15	1,400	2,660	4,750	5,300
	Bean Shoals	1,300	100	11,800	23,600	35,000	47,000
Ararat	Mouth	230					
	Station	280					
	Matthews Mill—Sta. 397+68	270	80	1,965	3,930	6,900	7,850
	Horseshoe Bend—						
	Sta. 305+43	240	60	1,050	2,620	3,930	5,240
	Sta. 205+20	230	50	836	1,565	2,090	3,140
	Sta. 123+19	220	42	673	1,000	1,510	2,100
	Hiatt's Sta. 15+70	200	20	290	363	545	728
Fisher	Mouth	156					
	Horseshoe Falls	112	100	815	2,040	3,050	4,070
	Skull Camp Mountain	28	200	510	1,020	1,530	2,040
Mitchell	Mouth	{112					
		{110					
	Kapp's Mill	38	100	345	690	1,035	1,380

NOTE.—To obtain 12-hour power multiply figures given by 2. To obtain 10-hour power multiply figures given by 2.4.

The stations shown in Table I, and on Figs. 2 and 4, indicate the distance in hundreds of feet below the highway bridge at Douglass Ford. Above this point developments in excess of 500 horsepower cannot be

made, owing to the proximity of the railroad to the river between Ararat and Mount Airy. Above Mount Airy there are a number of sites which might be developed up to 400 horse power—but none were examined which seemed possible of economical development to as much as 500 horsepower. All sites noted above are shown on the general sketch map of Surry County attached hereto. Table II gives monthly discharge at the highway bridge at Douglass Ford from October, 1920, to February, 1922, inclusive. This station was established in the summer of 1920, and daily observations have been taken since September, 1920.

TABLE II.—DISCHARGE OF THE ARARAT RIVER AT PILOT MOUNTAIN, N. C.
Drainage Area, 200 Square Miles

Year	Month	Discharge in Second-feet				Run-off Depth in Inches on Drainage Area
		Maximum	Minimum	Mean	Per Square Mile	
1920	August	1,193	215	525	2.62	2.97
	September	1,340	215	367	1.83	2.04
	October	470	143	232	1.16	1.32
	November	2,540	171	495	2.48	2.76
	December	3,000	415	679	3.40	3.86
1921	January	2,750	360	627	3.13	3.55
	February	2,535	472	723	3.62	3.77
	March	710	400	456	2.28	2.58
	April	2,090	318	551	2.75	3.07
	May	730	360	453	2.26	2.57
	June	1,240	230	392	1.96	2.19
	July	1,520	190	410	2.05	2.32
	August	340	132	215	1.06	1.20
	September	610	80	180	.80	1.01
	October	2,710	75	216	1.08	1.23
	November	1,490	190	320	1.63	1.82
	December	350	115	219	1.10	1.24
	The year	2,750	75	392	1.985	26.45
1922	January	720	138	248	1.24	1.40
	February	1,222	298	504	2.52	2.85

FISHER RIVER

The Fisher River is quite lacking in really excellent dam sites, that at the Horseshoe Bend, southeast of Dobson, being the only one of note on the river. The river makes a sharp bend here, flowing in a narrow gorge over a series of shoals, giving a total fall of about 10 feet. A profile of the river from the highway bridge below Bear Creek to the highway bridge from Dobson to Mount Airy is shown on Fig. 6.

Horseshoe Bend.—There is also shown on the same figure a cross section of the dam site at the Horseshoe Bend. It should be noted that there is a gap beyond the crest of the hill on the right bank, and this

precludes a higher dam than 50 feet without a dike across this saddle. A 50-foot dam would develop about 760 continuous primary horsepower, or 1,800 10-hour primary power with storage. With auxiliary power, a development could well be made for probably 50 per cent in excess of these figures.

It would be quite feasible to construct here a dam 100 feet or more in height, but this would necessitate a dike across the gap. Either dam would mean relocation of the present Mount Airy-Dobson highway. A 100-foot dam would develop probably 2,000 continuous or 6,000 12-hour primary power. With auxiliary power it would be economical to develop possibly 4,000 or 4,500 horsepower for general use, or for an electric furnace or other similar industry. No local market exists as yet for the use of so much power. This development, however, is one of the most attractive in the region, and owing to the exceptional dam site could be constructed relatively cheaply. Some valuable agricultural land would, however, be flooded. A contour map of the region immediately above the dam site is shown in Fig. 7. A scheme for interconnection of this power with others is considered later in the report.

TABLE III.—GAGE HEIGHTS ON FISHER RIVER, DOBSON, N. C.—1920–1921

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	
1.......	......	0.77	0.72	1.97	1.73	1.12	1.02	0.88	0.87	0.73	0.77	0.77	0.49	1
2.......	......	.73	.72	1.95	1.72	1.12	1.02	.92	.93	.67	.78	.73	.61	2
3.......	......	.82	.68	1.92	1.73	1.14	1.02	.85	.97	.73	.77	.77	.56	3
4.......	......	.77	.67	1.86	1.72	1.13	.97	.82	.93	.87	.73	.78	.50	4
5.......	.75	.75	.64	1.83	1.72	1.17	.94	.77	.85	.73	.74	.86	.52	5
6.......	.73	.72	.62	1.82	1.72	1.12	.97	.73	.75	.72	.72	.84	.52	6
7.......	.78	.72	1.62	1.96	1.67	1.15	.95	.78	.73	.75	.67	.86	.49	7
8.......	.73	.72	1.73	1.93	1.73	1.17	.93	.77	.97	.78	.63	.87	.51	8
9.......	.78	.72	1.73	1.85	1.73	1.18	.87	.83	.93	.83	.57	.94	.74	9
10.......	.75	.72	1.85	1.73	1.76	3.12	.85	.73	.87	.87	.73	.95	.51	10
11.......	.73	.72	1.93	1.75	1.84	1.18	.83	.72	.87	.88	.74	.94	.52	11
12.......	.72	.68	1.95	1.85	1.83	1.13	.78	.77	.77	.73	.73	.87	.51	12
13.......	.75	.66	1.82	4.05	1.77	1.13	.74	.83	.74	.72	.75	.85	.47	13
14.......	.73	.64	1.93	5.05	1.98	1.15	.75	.73	.87	.67	.77	.94	.47	14
15.......	.83	.72	2.05	1.32	1.82	1.12	.74	.83	.87	.64	.76	.95	.45	15
16.......	.75	.72	2.45	1.34	1.77	1.07	.73	.92	.83	.67	.78	.97	.46	16
17.......	.73	.72	2.82	1.13	1.75	1.06	.73	.97	.83	.72	.93	.87	.48	17
18.......	.72	.72	1.93	1.93	1.72	1.12	.75	.93	.77	.63	.92	.84	.46	18
19.......	.77	.72	1.83	1.82	1.82	1.13	.72	.87	.73	.73	.87	.86	.46	19
20.......	.75	.72	1.82	1.73	1.77	1.17	.73	.83	.77	.74	.83	.88	.45	20
21.......	.73	.72	1.82	1.75	1.73	1.20	.74	.77	.73	.73	.78	.54	.48	21
22.......	.62	.72	1.95	1.77	1.72	1.17	.77	.73	.87	.68	.76	.54	.70	22
23.......	.65	.72	1.97	1.03	1.14	1.15	.83	.77	.83	.64	.74	.53	.51	23
24.......	2.55	.72	1.92	1.87	1.13	1.12	.87	.83	.87	.67	.97	.52	.47	24
25.......	.77	.72	1.82	1.77	1.03	1.12	.85	.77	.95	.74	.95	.55	.49	25
26.......	.75	.72	1.73	1.75	1.05	1.07	.77	.73	.93	.73	.87	.55	.52	26
27.......	.72	.72	1.75	1.73	1.03	1.05	.73	.83	.73	.74	.85	.53	.51	27
28.......	.78	.82	1.73	1.83	1.02	1.03	.72	.93	.77	.72	.73	.48	.51	28
29.......	.77	.75	1.70	1.82	1.04	......	.75	.97	.87	.74	.78	.51	.50	29
30.......	1.52	.72	1.97	1.77	1.15	......	.78	.97	.83	.78	.76	.55	.54	30
31.......	......	.72	......	1.75	1.13	......	.83	......	.77	......	.75	.51	......	31

Skull Camp Mountain Site.—There is an excellent dam site at the foot of Skull Camp Mountain, where a 200-foot dam could be constructed. This would necessitate a long earth section, but there is excellent storage above the site. It is probable that from 1,200 to 1,800 primary continuous power could be developed here, which could readily be interconnected with the development near Dobson noted above.

No other exceptionally good dam sites were noted on Fisher River. In general, where the banks are steep on one side, the valley is broad on the other. A number of sites exist where low dams might be cheaply constructed to develop from 100 to 400 primary horsepower. Gage readings at Dobson from October, 1920, to March, 1921, inclusive, are given in Table III. A rating curve has not yet been constructed, but will be prepared within a few months.

MITCHELL RIVER

This river, like the Fisher, presents few opportunities for economical development of dam sites to produce in excess of 500 primary horsepower. About one mile above Douglass mill dam, and about 1½ miles above the mouth is a possible site where a dam 40 feet high would develop about 350 continuous primary horsepower, or 700 12-hour horsepower. From this point up the river no really good dam sites occur until Kapp's mill is reached, and about 10 miles above the mouth. The river has a much steeper slope than either the Ararat or Fisher rivers, rising about 15 feet per mile. It is possible, therefore, to develop low dams from 8 to 12 feet high at a number of places and gain additional height by means of a flume or canal carried along the banks. The power to be obtained by such developments may be said roughly to approximate 7 continuous primary horsepower per foot of fall.

Kapp's Mill Site.—At Kapp's mill a fair dam site exists. A cross section of this, together with profile of the river, is shown on Fig. 8. A dam 100 feet high would develop approximately 700 primary continuous power, or a 10-hour power of 1,680 horsepower.

On the headwaters of the Mitchell River some high falls are available, up to 250 feet, but although as much as 500 continuous primary horsepower could be developed at some of these, the remote location, and the difficulty of getting in construction materials make them not feasible economically for development at the present time.

ELKIN RIVER

This stream flows for only a few miles in Surry County, and no undeveloped dam sites are available. A description of the powers on the upper part of this stream will be found in the report on the water powers of Wilkes County.

YADKIN RIVER

Bean Shoals.—The Yadkin River forms the southern boundary of Surry County, and at Bean Shoals, between Boyden and Shoals on the Southern Railroad is located the best undeveloped power in Surry County. The shoals here extend a distance of six miles from Shoals Station to Donnaha, with a total fall of 40 feet. By far the larger amount, however, occurs in the two miles between Shoals and Boyden stations, the fall in this distance being 27 feet. No dam sites as good as at Shoals occur below this point, and the remaining fall of the shoals is not regarded as possible of economical development in the near future.

There are two good dam sites located near the foot of the first portion of the falls, about one-half mile west of Boyden Station. There are rock hills coming close to the river on each side, and at one site there is a large island in the middle of the stream, which would greatly simplify construction. The rock lies on edge normal to the direction of the river, and foundations for any type of masonry dam would be excellent. Due to the presence of the railroad, construction materials could readily be brought in, and there is an abundance of local sand and rock.

The chief drawback to the early development of these sites is the location of the North Wilkesboro branch of the Southern Railroad, which runs parallel to the river, and not far above it. Any development for more than 15 feet at the dam would necessitate relocation of the railroad. It should be said in this connection that a line has been surveyed from Shoals to Tobaccoville by another route, following a higher contour. Such relocation would be very advantageous in eliminating costly grades between Shoals and Tobaccoville on the present line. By removing the railroad, a dam from 60 to 100 or more feet in height could readily be built. The limit in height would depend chiefly on the cost of flood rights, for a dam 180 feet high would back water to North Wilkesboro, 53 miles above, and would flood portions of the town of Elkin, and quite submerge the small villages of Burch, Crutchfield, and Rockford, as well as much valuable bottom land.

Table IV shows the distance to which backwater would rise from dams of different heights. It is believed that it will never prove profitable to flood Elkin, and the maximum height of dam is thus limited to about 112 feet. This would develop at least 26,400 primary continuous horsepower. The data in Table IV relating to power capable of being developed are extremely conservative, and in most instances the figures there given will probably be exceeded in practice. Profiles of Bean Shoals are shown in Figs. 9 and 10. The profile of the Yadkin River, Fig. 9 (in pocket), shows the rise from the foot of Bean Shoals to North Wilkesboro, and data in Table IV is taken from this. Fig. 12 shows a contour map from the dam site to above Shoals Station. Some idea of the character of the valley and the amount of storage may be obtained from this, and also from the general maps of the Yadkin Valley, Fig. 15.

TABLE IV.—BACKWATER ELEVATIONS FROM DAM AT BEAN SHOALS ON YADKIN RIVER
Drainage Area, 1,300 Square Miles

Height of Dam in Feet	Backwater Reaches to—	Horsepower Developed		
		12 Months	6 Months	3 Months
18	Railroad below Shoals	1,700	4,250	6,350
30	Siloam Station	3,550	7,100	10,650
40	Railroad at Siloam Station	4,750	9,460	13,190
55	Rockford	7,800	13,000	19,500
64	Railroad at Rockford	11,350	18,900	26,500
78	Crutchfield	16,600	23,000	27,600
88	Railroad at Crutchfield	20,800	31,200	41,600
112	Elkin	26,400	29,700	52,800
135	Railroad at Elkin	31,900	47,800	63,800
135	Ronda			
145	Railroad at Ronda			
187	North Wilkesboro			
200	Railroad at North Wilkesboro			

Fig. 11 shows relative profiles of the river bottom and railroad from the dam site to Shoals. It is evident that under present conditions a 15-foot dam might be built without flooding the railroad, especially if the channels were widened by cutting into each side of the island. Such a dam would be about 1,100 feet long, and would develop approximately 1,400 continuous or 3,360 10-hour primary horsepower. The storage developed is about 85,000,000 cubic feet. The drainage area above the dam site is about 1,300 square miles and this figure may be used in computing storage. The percentage of time that given flow and power can be maintained are derived from the duration curves of Fig. 16. In a general way data from Fig. 16 is applicable to all the streams in Surry County.

INTERCONNECTION OF POWER PLANTS

In the development of hydro-electric projects in a new country, such as the region about Surry County, it is greatly to be desired that all installations be planned with a view to eventual interconnection. In this way, when the load at one place is high surplus power from another place may be brought in. It is thus possible to have smaller machinery installations at a given plant, with consequent less idle machinery during periods of average load. Interconnection of plants means much greater economy in operation, and usually less initial cost. Frequently it is possible to do away with steam auxiliary.

For this reason there has been indicated on the sketch map of Surry County a transmission line connecting the principal developments noted above. It is strongly urged that any enterprises looking to the development of one or more of the sites described herein should consider very

carefully the construction of a unit which will fit into this interconnected system. Eventually it is hoped that the whole State will be served by a network of interconnected transmission lines.

A very desirable scheme would seem to be the development of Matthews dam site, on the Ararat, with the Horseshoe dam site on the Fishers River—interconnection of the two, and transmission for use to Winston-Salem. Primary power of 6,000 continuous horsepower could probably be developed, and by use of auxiliary power at Winston-Salem the two projects could probably be developed for between 8,000 and 10,000 horsepower. The distance from Horseshoe Bend on Fishers River to Matthews mill on the Ararat is about 10 miles, and from Matthews mill to Winston-Salem the distance is about 25 miles. It would probably be more attractive still to construct a longer transmission line, by going from Horseshoe Bend to Dobson, thence to Mount Airy, then south along the railroad to Rural Hall and Winston-Salem. A considerable market for power exists in all the small towns along the line, and the existing hydro-electric plant on the Ararat at Mount Airy could then be tied in. The capacity of the whole system, with Matthews mill connected in, would then be in the neighborhood of 7,000 primary continuous horsepower, and could well support an installation of 12,000 horsepower with auxiliary power. At Winston-Salem it would, of course, be possible, and probably desirable, to tie into the Southern Power Company's lines.

In connection with any scheme of interconnection of powers in this region, the counties of Surry, Wilkes, and Ashe should be regarded as a unit. The interconnection of powers on Roaring, Reddies, and the New rivers mentioned in the Wilkes County report should be carried out in combination with the interconnection of the powers mentioned in this report.

TABLE V.—DISCHARGE OF YADKIN RIVER AT DONNAHA—1913-1920

Month	Discharge in Second-feet				Run-off Inches on Drainage Area
	Maximum	Minimum	Mean	Per Square Mile	
1912-1913					
April 11-30	12,000	2,320	3,810	2.38	1.77
May	16,600	2,170	3,990	2.49	2.87
June	5,290	1,460	2,660	1.66	1.85
July	3,680	1,460	1,910	1.19	1.37
August	10,400	1,460	3,010	1.88	2.17
September	5,290	1,050	2,360	1.48	1.65
October	10,700	1,050	2,000	1.25	1.44
November	5,290	1,320	1,710	1.07	1.19
December	6,610	1,460	2,250	1.41	1.63
1913-1914					
October	10,700	1,050	2,000	1.25	1.44
November	5,290	1,320	1,710	1.07	1.19
December	6,610	1,460	2,250	1.41	1.63
January	6,100	1,600	2,270	1.42	1.64
February	5,770	1,880	3,220	2.01	2.09
March	7,630	1,880	2,680	1.68	1.94
April	6,610	2,030	2,960	1.81	2.02
May	4,160	1,320	2,200	1.38	1.59
June	1,880	1,180	1,460	.912	1.02
July	7,630	1,050	2,030	1.27	1.46
August	2,320	815	1,240	.775	.89
September	1,320	720	992	.620	.69
Year	10,700	720	2,070	1.29	17.60
1914-1915					
October	26,400	1,250	4,470	1.31	1.51
November	7,210	1,690	2,510	.738	.82
December	50,200	3,790	12,000	3.53	4.07
January	54,400	4,240	11,300	3.32	3.83
February	24,800	4,400	8,170	2.40	2.50
March	9,580	3,790	5,060	1.49	1.72
April	5,050	3,070	3,810	1.12	1.25
May	8,370	2,800	3,960	1.16	1.34
June	32,800	2,060	5,560	1.64	1.83
July	4,400	1,630	2,540	.747	.86
August	32,800	1,690	6,340	1.86	2.14
September	22,700	1,940	4,520	1.33	1.48
Year	54,400	1,250	5,850	1.72	23.35

TABLE V.—DISCHARGE OF YADKIN RIVER AT DONNAHA, 1913-1920—*Con.*

Month	Discharge in Second-feet				Run-off Inches on Drainage Area
	Maximum	Minimum	Mean	Per Square Mile	
1915-1916					
October	10,100	1,460	2,170	1.35	1.556
November	4,810	1,600	1,942	1.21	1.350
December	14,700	1,600	3,147	1.96	2.186
January	9,370	2,470	3,302	2.06	2.375
February	11,970	2,320	3,619	2.23	2.405
March	3,070	2,030	2,211	1.38	1.591
April	2,170	1,740	1,930	1.20	1.339
May	7,090	1,600	2,221	1.38	1.591
June	6,250	1,740	2,301	1.43	1.595
July	16,600	1,600	4,411	2.75	2.966
August	7,940	2,470	3,517	2.19	2.525
September	4,330	2,030	2,462	1.53	1.706
Year	16,600	1,460	2,769	1.72	23.185
1916-1917					
October	10,100	2,175	2,948	1.84	2.08
November	2,470	1,880	2,063	1.29	1.43
December	2,470	1,880	2,022	1.26	1.45
January	2,770	2,030	2,282	1.43	1.65
February	5,610	2,175	3,094	1.93	2.08
March	9,740	2,310	4,618	2.88	3.32
April	9,370	1,880	2,741	1.71	1.90
May	3,990	1,880	2,216	1.38	1.59
June	2,470	1,880	2,120	1.32	1.47
July	8,310	1,600	2,606	1.63	1.88
August	2,030	1,320	1,465	.915	1.05
September	11,400	1,320	2,153	1.34	1.49
Year	11,400	1,320	2,527	1.57	21.39
1917-1918					
October	3,220	1,180	1,474	.92	1.06
November	6,420	1,180	1,708	1.07	1.19
December	1,880	1,080	1,551	.97	1.12
January	8,310	1,050	2,665	1.67	1.93
February	2,470	1,600	1,904	1.19	1.24
March	2,770	1,460	1,767	1.10	1.27
April	8,990	1,460	2,120	1.32	1.47
May	2,770	1,600	1,712	1.07	1.23
June	8,140	1,320	2,092	1.31	1.46
July	6,750	1,460	2,175	1.35	1.56
August	5,610	1,460	2,275	1.42	1.64
September	3,370	1,600	1,959	1.22	1.36
Year	8,990	1,050	1,950	1.21	16.53

TABLE V.—DISCHARGE OF YADKIN RIVER AT DONNAHA, 1918-1920—*Con.*

Month	Discharge in Second-feet				Run-off Inches on Drainage Area
	Maximum	Minimum	Mean	Per Square Mile	
1918-1919					
October	7,310	1,600	2,355	1.47	.67
November	3,450	1,670	1,997	1.24	.37
December	7,770	1,810	2,655	1.65	1.80
January	5,220	1,880	2,881	1.80	
February	3,760	1,810	2,146	1.34	[illegible]
March	8,480	1,880	2,565	1.60	.84
April	2,300	1,880	2,082	1.30	[illegible].44
May	7,110	1,880	2,642	1.65	1.89
June	9,690	1,880	3,002	1.87	[illegible]07
July	15,300	1,740	3,872	2.42	[illegible]63
August	3,150	2,170	2,467	1.54	.77
September	2,920	2,030	2,247	1.40	1.55
Year	15,300	1,500	2,576	1.60	20.70
1919-1920					
October	4,160	2,030	2,272	1.42	1.63
November	2,620	2,030	2,210	1.38	1.58
December	5,210	2,030	2,567	1.60	1.74
January	2,770	1,880	2,127	1.33	1.53
February	4,820	2,030	2,261	1.66	1.92
March	5,930	2,170	3,389	2.11	2.43
April	13,500	2,310	4,533	2.83	3.26
May	2,620	1,880	2,218	1.38	1.58
June	5,930	2,030	2,534	1.58	1.82
July	6,250	2,030	2,624	1.64	1.89
August	11,800	1,880	4,168	2.59	2.98
September	11,000	2,470	3,665	2.29	2.64
Year	13,500	1,880	2,880	1.81	25.00

TABLE V.—DISCHARGE OF YADKIN RIVER AT DONNAHA, 1913-1920—*Con.*

Month	Discharge in Second-feet				Run-off Inches on Drainage Area
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October	7,310	1,600	2,355	1.47	1.67
November	3,450	1,670	1,997	1.24	1.37
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February	3,760	1,810	2,146	1.34	1.51
March	8,480	1,880	2,565	1.60	1.84
April	2,300	1,880	2,083	1.30	1.44
May	7,110	1,880	2,642	1.65	1.89
June	9,690	1,880	3,002	1.87	2.07
July	15,300	1,740	3,872	2.42	1.63
August	3,150	2,170	2,467	1.54	1.77
September	2,920	2,030	2,247	1.40	1.55
Year	15,300	1,500	2,576	1.60	20.70
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October	4,160	2,030	2,272	1.42	1.63
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December	5,210	2,030	2,567	1.60	1.74
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May	2,620	1,880	2,218	1.38	1.58
June	5,930	2,030	2,534	1.58	1.82
July	6,250	2,030	2,624	1.64	1.89
August	11,800	1,880	4,168	2.59	2.98
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Year	13,500	1,880	2,880	1.81	25.00

PART II

WATER POWERS OF WILKES COUNTY

BY

THORNDIKE SAVILLE, HYDRAULIC ENGINEER

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PART II

LIST OF MAPS AND PROFILES

[ENCLOSED IN POCKET ATTACHED TO BACK COVER]

LIST OF TABLES

PART II

WATER POWER SURVEY OF WILKES COUNTY

By THORNDIKE SAVILLE, *Hydraulic Engineer*

INTRODUCTION

Location.—Wilkes County is in the northwest section of the State. It is bounded on the north and west by the Blue Ridge and the counties of Alleghany, Ashe, and Watauga, on the west by Surry and Yadkin counties, and on the south by Iredell, Alexander, and Caldwell counties. The Yadkin River runs through the center of the county. The elevation above sea level is generally high, varying from about 890 feet at Lovelace, near the southeast border, to 4,055 feet at Tomkins Knob, on the Blue Ridge.

Climate.—The climate is that of the upper Piedmont and Mountain regions. At North Wilkesboro, the principal city (population 2,500, elevation 970), there is a mean annual rainfall of about 52 inches. At Brewers, elevation 1,950, located 16 miles north of North Wilkesboro, the average mean maximum and mean minimum temperatures are 56.7, 69.5, and 43.9 degrees respectively. The extremes of temperatures at Brewers range from a maximum of 100 to a minimum of —9 degrees Fahrenheit. The average date of the first and last killing frosts is October 14 and April 20, respectively. The climate is considerably more moderate in the southeast section of the county, especially along the valley of the Yadkin. The State Geological Survey arranged with the U. S. Weather Bureau to have a rain gage installed at North Wilkesboro, and records commenced in October, 1921.

Agriculture.—In the central and southeastern parts of the county, especially in the rich and fertile valleys of the Yadkin and its tributaries, a large amount of fine tobacco is raised. In the uplands to the north and west of North Wilkesboro there exists in the "thermal belt" one of the finest fruit-growing regions in the United States, and great quantities of apples, cabbage, etc., are shipped to all parts of the country. The average temperature in the "thermal belt" is approximately 10 degrees higher in winter and 10 degrees lower in summer than in the adjacent valleys. Lately much attention has been given to the raising of corn and wheat, many farmers raising over 30 bushels of wheat to the acre. Wilkes County ranks third in the 100 counties of the State in the number of farms, having over 4,000 in 1920. Lumbering is an important industry, there being over 100,000 acres of virgin and 150,000 acres of second-growth timber available in the county. Ten million feet of lumber are exported annually.

Forests.—North Wilkesboro and Wilkesboro are the center of one of the greatest virgin forest areas of the United States. In Wilkes County

alone there are 100,000 acres of virgin timber land and 150,000 acres of second-growth timber. The former will produce one billion feet of merchantable timber, 700,000 cords of pulp wood, and 700,000 cords of extract wood. The latter will produce 300,000,000 feet of lumber, 2,000,000 cords of extract wood. North Wilkesboro or vicinity should offer most attractive sites for successful operation of the following industries: pulp mills, furniture factories, match factories, handle factories, woodworking factories, ready-cut house factories. There is a larger stand of white pine in Wilkes County, and within a thirty-mile radius of the Wilkesboros than in any other section east of the Mississippi River. Within a thirty-mile radius of the Wilkesboros there are 200,000 acres of virgin timber, and 900,000 acres of second-growth timber, all accessible by good roads or a logging road proposition. Eleven million cords of pulp wood are available in this radius, and it is still growing.

Manufactures.—North Wilkesboro is the greatest manufacturing center in the northwest section of the State, having an annual output of manufactured goods exceeding $8,100,000 in value. There are nine factories in the district making corn mills, which are shipped all over the world. The largest tannery in the State is located at North Wilkesboro, where aboundant supplies of tan bark are readily procurable. The total value of manufactured products from this section is about $11,000,000 annually. The section is especially attractive from an industrial point of view from the cheap water power available, and the excellent labor supply furnished by the native population.

Transportation.—North Wilkesboro is the shipping center for the entire county, and also for a large portion of the adjacent counties of Ashe, Alleghany, and Watauga. This town is the western terminus of the branch line of the Southern Railroad from Winston-Salem and Greensboro. North Wilkesboro is the chief shipping point in the entire State for the export of poultry, hardwoods, roots, herbs, medicinal bark, canned goods, cornmills, and produce. The roads program recently adopted by the State contemplates a number of additional improved roads from North Wilkesboro to the adjacent sections, and as these will be under way early in 1921, large areas of this undeveloped section will be opened up with consequent increase in agriculture and industry. The Wilkes Commercial Club of North Wilkesboro will furnish information relating to the natural resources and other advantages of the region.

Altogether, this section of the State, known long ago as the "lost provinces," bids fair soon to become one of the most flourishing districts, due to improved roads, agricultural advantages in soil and climate, the excellence of the native labor supply, the amount and variety of its natural resources, and the abundance of undeveloped water power so situated as to be economically developed.

A series of definitions of terms used in water power studies and in this report is given on pages 14 and 15 in the Surry County report.

WATER POWERS

The principal streams of the region, in order of importance, are the Yadkin, Roaring, and Reddies rivers and Lewis Fork. The Elkin River cuts across the southwestern edge of the county for a few miles.

A list of the streams of Wilkes County, together with data relating to drainage area, fall, and power is given in Table I. The power shown is continuous, or 24-hour power. Where 10-hour or 12-hour use is desired, the amounts of power shown should be multiplied by 2.4 or by 2, respectively.

ELKIN RIVER

This stream flows in a northwesterly direction in the eastern section of the county, crossing the county line a few miles north of Elkin and emptying into the Yadkin River. There are no large undeveloped powers. The stream itself is not large, and the best site has already been developed by the Elkin Power Company. A fall of 80 feet has been developed for 190 horsepower for use by the town of Elkin. There are two other small developments near Elkin, one belonging to the Elkin Shoe Company and the other to the Chatham Manufacturing Company, both being for 100 horsepower with 12-hour use.

A profile of the river is shown in Fig. 2. The only undeveloped site of any consequence is at station 85+00, where a dam of maximum height of 45 feet would develop approximately 95 horsepower continuously.

ROARING RIVER

This is the largest tributary of the Yadkin in Wilkes County, but in the lower reaches, several miles south of Dockery, the valley is so wide that no good dam sites are available. The best location for a dam in this portion of the river is about three miles below Dockery, at approximately station 270+00 on the profile, Fig. 3. A dam here 150 feet high gives large storage, and the power possibilities are excellent. Such a dam, located less than six miles from the railroad, would give approximately the power shown in Table I. This is equivalent to 7,550 12-hour power during the entire year.

Above Dockery there are numerous excellent dam sites, where dams from 50 to 200 feet high could be readily built. Such dams might serve at first as storage dams to regulate the power developments lower down, but with provision for installing generating equipment as the power market grew. As storage dams alone, such developments would increase the average utilizable yield of the river from 150 to 250 per cent.

TABLE I.—DRAINAGE AREAS AND POWER ON WILKES COUNTY STREAMS

Stream	Location	Drainage Area Tributary in Square Miles	Maximum Fall in Feet	Minimum Power Without Storage 80% Eff.	Continuous Horsepower Available With Storage		
					12 Months	6 Months	3 Months
Yadkin River	North Wilkesboro	490					
	Barlow Shoals	220	100+		2,400	4,800	9,000
	Tinsley Shoals	235	15	350		*580	
	Marley Shoals	250	15	375		*620	
	Dam site between North Wilkesboro and Elkin	560	60		4,600	7,000	12,000
Elk Creek	Mouth	49					
	Dam Site No. 1	47	125		1,100	1,600	2,200
	Wilkes County	24					
	Watauga County	25					
Stony Creek	Mouth	42					
Lewis Fork	Mouth	73					
	East Fork Dam Site	26	50	180	210	295	350
	West Fork Dam Site	31	50	210	250	350	420
	Headwaters, High Head developments			1,500	1,500		
Reddies River	Mouth	93					
	Dam site at town of Reddies River	61	100+		1,110	1,660	3,330
	East Fork	6.9	Indiv	idual			
	North Fork	31.4	devel	op-			
	Middle Fork	15.2	ment	s on all			
	South Fork	14.5	these	streams			
			total	ing	2,500		
			(See	text)			
Mulberry River	Mouth	43		†			
Roaring River	Mouth	137					
	Dam site below Dockery	120	150		3,275	5,000	8,200
Elkin River	Mouth	35					
	Dam site	23	45	94	140	200	300
Warrior Creek	Mouth	27		‡			
Totals					17,085	20,905	35,800

NOTE.—To obtain 10-hour or 12-hour power multiply figures given by 2.4 or 2.0 respectively.
*Indicates power developed during six high-water months.
†No powers in excess of 250 H. P. ‡No powers in excess of 100 H. P.

REDDIES RIVER

This stream enters the Yadkin at North Wilkesboro. Throughout its lower reaches it has little fall and no good dam sites. There is a small development at North Wilkesboro for 190 horsepower, utilizing a head of 21 feet. Above North Wilkesboro the stream offers no opportunity for any considerable development in excess of 900 to 1,200 horsepower. Below the town of Reddies River, where the topography changes to a mountainous character, there exists splendid opportunity for locating a dam 100 or more feet high to provide excellent storage. The estimated

power is shown in Table I, and is equivalent to 2,200 continuous 12-hour horsepower during the year. A higher dam would develop more. A typical cross section taken at Whittington's mill is shown on the profile, Fig. 4.

On the several forks of the stream above the town of Reddies River numerous excellent dam sites exist. At these sites high dams can be built to develop from 300 to 600 continuous 12-months horsepower, and all of them can be located sufficiently above the Reddies River dam site not to be affected by it. Opportunities exist here for a combination of a number of small automatic stations on the forks to be tied in to a controlling station below Reddies River postoffice, to develop a total of possibly 4,500 continuous 24-hour horsepower during the year. The location of sites for the smaller developments has not been attempted, as they should be planned with a view toward interconnection, and for this purpose a detailed study is desirable. It is evident that sufficient sites exist and can be located easily. Transmission distance to North Wilkesboro is only ten miles from Reddies River.

Some such development as outlined above is probably the most satisfactory and economical method to be pursued in bringing additional power to North Wilkesboro. The smaller developments, of from 300 to 600 horsepower, might be made first, the development above North Wilkesboro next, and the larger controlling development at Reddies River later. The whole should be planned from the start, however, and with a view toward ultimate interconnection. A detailed study of this project might well be made by the town of North Wilkesboro, to outline to prospective industrial enterprises the cheap water power available and the ultimate plan for large development. Industries would then be tempted to locate near the town where rail facilities existed, and enter an association formed to develop the water powers and bring the electricity to North Wilkesboro for use. The plan outlined above appears very attractive, and it is believed would prove relatively economical to carry out.

LEWIS FORK

This stream, like most of the rivers of this section, has no good power possibilities in its lower reaches, due to a wide valley with large sandy bottoms, although there is a steep gradient, as shown by the profile, Fig. 5. The good dam sites exist on the East and West Forks, and cross section of selected sites are shown on the profiles, Figs. 6 and 7. The powers which may be economically developed here are shown in Table I, but the developments are handicapped, due to the limited drainage and storage areas above the dam sites. It will be a long time before these sites can be developed profitably, as other larger and better sites exist nearer North Wilkesboro, which provides the only present market for power.

There exist two or three opportunities for high head development on the headwaters of the Forks. On the East Fork, particularly, a development for between 800 and 1,000 continuous horsepower could be made, utilizing a fall of 800 feet, and with a pipe line between one and two miles long. Such a development could be most advantageously made to tie into the proposed developments on the headwaters of the branches of Reddies River noted in the previous section. On these two streams, Reddies River and Lewis Fork, there is located some 6,000 horsepower which can be economically developed in relatively small units as needed, and all of which is within a radius of 16 miles from North Wilkesboro.

ELK CREEK

Elk Creek is the westernmost stream in the county upon which any considerable power developments may be made. Almost one-half its total drainage area is in Wilkes County, the remainder being in Watauga County. A number of good dam sites exist on the stream in Wilkes County upon which might be constructed dams from 100 to 150 feet in height. A typical development is indicated in Table I. The sites are so far removed from existing markets that it is doubtful if they can be profitably developed at present.

YADKIN RIVER

Between North Wilkesboro and Elkin there are in Wilkes County one or two possible dam sites on the Yadkin River. The maximum development would be for about 60 feet, and would give a continuous 12-months power of about 4,600 horsepower as shown in Table I. Such a development, however, would necessitate relocation of the Southern Railroad between the dam site and North Wilkesboro, and with present undeveloped sites available elsewhere in the region, this would not prove at present an economical development. In the future, however, a development at Bean Shoals, near Shoals Station (see Surry County Water Power Report), to pond water to Elkin, and then a development above Elkin to pond water to North Wilkesboro would make available some 30,000 horsepower for continuous all-the-year-round use. A profile and a plan of the Yadkin River from Salisbury to North Wilkesboro is appended hereto (in pocket), and shows the effect of developments made as described above.

So far as developments on the Yadkin in the near future are concerned, much the best opportunity is afforded at sites above North Wilkesboro. Here, too, a railroad (the Watauga and Yadkin River Railroad) parallels the stream, but for some years this road has not been in operation, and the cost of either buying right of way or relocation should not be excessive. Moreover, low dams may be built to a height of 15 feet without damaging the railroad. The first good site is about nine miles above North Wilkesboro, at Marley Ford. A dam built here to a height of 15 feet would not interfere with the railroad, and would not

back water to the Tinsley Shoals site above. This is an attractive site for location of an industry, as the railroad can readily be placed in serviceable shape and will enable a dam to be constructed cheaply, and later furnish excellent transportation facilities.

Tinsley Shoals.—At Tinsley Shoals, about 12 miles from North Wilkesboro, there are two good dam sites, that at the head of the shoals being the better. A cross section of each is shown on the profile, Fig. 8. Here two 15-foot dams might be built without injuring the railroad, each giving substantially the power as shown in Table I. A map is shown in Fig. 9.

Barlow Shoals.—At Barlow Shoals, about 15 miles above North Wilkesboro, there is an excellent dam site, shown in cross section on Fig. 8. Should a 100-foot dam be built here, flooding out the railroad, a considerable power might be developed as shown in Table I. There is excellent storage above this site, as the river broadens out in the Yadkin Valley. This is a farming region, and flood rights are likely to be expensive. It is possible, therefore, that Marley Ford or Tinsley Shoals would prove a better location for a high dam, inasmuch as there is from 20 to 30 feet fall to be gained by going down the river to those sites. Moreover, this might also affect less certain developments on Elk Creek, which would be eliminated in the lower reaches by a dam at Barlow Shoals. All the sites mentioned offer good opportunities to develop from 2,000 to 3,000 continuous horsepower all the year. Which site should be selected and the height of dam is contingent upon (1) damage to railroad; (2) cost of site; (3) cost of flood rights. A development at Barlow Shoals, of course, still makes it possible to have low head developments with rail facilities at the two lower sites.

SUMMARY

The developments outlined in this report are such as can be economically made on streams in Wilkes County for amounts in excess of 200 horsepower continuous all the year round. There is a total of approximately 18,000 continuous 24-hour horsepower capable of development in Wilkes County within a radius of 20 miles of North Wilkesboro. Of this, about 9,000 horsepower, or one-half the total, can be developed without flooding existing railroads. Actual installations are rarely made for the continuous 24-hour power, since most industries operate on a 10-hour or 12-hour basis. It is probable that it is feasible to install between 25,000 and 35,000 horsepower on streams in Wilkes County, of which between 12,000 and 15,000 horsepower would not interfere with existing railroads.

INTERCONNECTION OF POWER PLANTS

In the development of hydro-electric projects in a new country, such as the region about North Wilkesboro, it is greatly to be desired that all installations be planned with a view to eventual interconnection. In

this way, when the load at one place is high, surplus power from another place may be brought in. It is thus possible to have smaller machinery installations at a given plant, with consequent less idle machinery during periods of average load. Interconnection of plants means much greater economy in operation and usually less initial cost. Frequently, it is possible to do away with steam auxiliary.

Probably in no part of North Carolina are natural conditions and economic considerations so favorable to interconnection as in the territory served by North Wilkesboro. The natural outlet from a vast agricultural, mining, forest, and fruit-growing region, with rapidly expanding local industries and good rail connections, the phenomenal growth of the city seems only to depend upon the initiative of its citizens in exploiting and making available the great undeveloped water power resources. It is to be expected that industries will locate in the neighborhood of the city as cheap power is made available. It will probably be desirable to develop this power at first in small blocks of from 500 to 2,000 horsepower. Numerous sites exist within a 15-mile radius of the city and their location is pointed out in this report. These should all be developed with a view to interconnecting them with each other, and eventually with some large controlling plant.

On the New River in Ashe County is a site owned by North Wilkesboro interests, and capable of developing some 10,000 continuous all-the-year horsepower. The details of this development are shown in Fig. 10, prepared from data loaned through the kindness of Mr. H. C. Landon of North Wilkesboro. This possible development is less than 25 miles from North Wilkesboro, and could be readily developed to supply a large industry and act at the same time as a central station into which all the smaller powers mentioned heretofore could be connected, as well as other moderate-sized developments in Ashe, Watauga, and Alleghany counties. There seems no reason to prevent the growth in this district of great manufacturing centers, since the distribution of large and small water powers is almost ideal. As stated previously, it is the fervent hope of the State Geological and Economic Survey that the several commercial organizations in Wilkes and adjacent counties will unite in having a detailed study made of the water powers of the district, with a view to the preparation of a definite plan for gradual development and interconnection.

For this reason, there has been indicated on the sketch map of Wilkes County a transmission line connecting the principal developments noted above. It is strongly urged that any enterprises looking to the development of one or more sites described herein should consider very carefully the construction of a unit which will fit into this interconnection system. Eventually it is to be hoped that the whole State will be served by a network of interconnected transmission lines.

It is evident that Wilkes County is in a very remarkable position as regards an unusual combination of natural resources in power and

agriculture, combined with excellent labor supply and good transportation facilities. There seems every reason to believe that with proper exploitation of these advantages there is great opportunity for the development in the district tributary to North Wilkesboro of a great agricultural, manufacturing, and industrial region. The North Carolina Geological and Economic Survey will be glad to receive inquiries relating to specific details of the matters outlined in this report, and to bring outside interests in touch with opportunities for locating in Wilkes County.

GAGING STATIONS

The development of water power projects is predicated upon the available stream flow. Consequently, long-period observations of stream flow, covering both wet and dry years, are exceedingly important in considering the water power resources of a region. The North Carolina Geological Survey, in coöperation with the United States Geological Survey, has for many years maintained gaging stations on North Carolina streams. In the Wilkes County district a gaging station was maintained on the Yadkin River at North Wilkesboro from 1903 to 1907, inclusive. The records from this station are appended hereto as Table II. The station was reëstablished in 1920, and daily observations of discharge are now being made. During 1922 there will be established similar gaging stations on Reddies River and Roaring River. It is believed that the data to be obtained from these stations will be of great value in indicating what stream flow may be depended upon for water power developments. The records from these stations will be published annually by the United States Geological Survey in its water resources papers dealing with the South Atlantic States. Records for any particular stream may be obtained by writing to the North Carolina Geological Survey.

TABLE II—ESTIMATED MONTHLY DISCHARGE OF YADKIN RIVER AT NORTH WILKESBORO, N. C.

Drainage area, 498 square miles

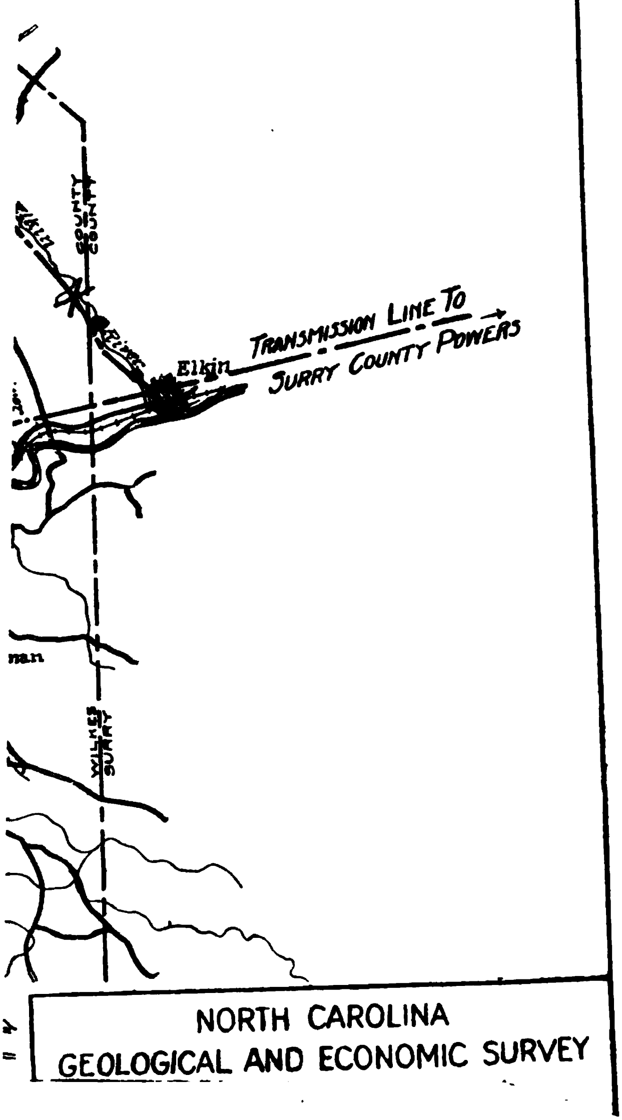
Month	Discharge in Second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per Square Mile	Depth in Inches
1903					
April 10-30	3,270	1,415	2,064	4.15	3.24
May	1,415	974	1,169	2.35	2.71
June	5,770	890	1,417	2.85	3.18
July	2,170	659	916	1.84	2.12
August	1,380	575	815	1.64	1.89
September	1,530	512	647	1.30	1.45
October	6,220	491	770	1.55	1.79
November	1,115	449	568	1.14	1.27
December	743	365	502	1.01	1.16
1904					
January	860	322	532	1.07	1.23
February	1,730	322	742	1.49	1.61
March	9,300	611	1,171	2.35	2.71
April	935	513	602	1.21	1.35
May	14,500	513	1,467	2.95	3.40
June	4.375	611	1,224	2.46	2.74
July	7,650	513	1,032	2.07	2.39
August	3,950	611	1,059	2.13	2.46
September	1,770	417	594	1.19	1.33
October	417	345	381	.765	.882
November	1,060	369	461	.926	1.03
December	1,285	369	506	1.02	1.18
The year	14,500	322	814	1.64	22.31
1905					
January	3,330	215	720	1.44	1.66
February	2,860	340	929	1.86	1.94
March	1,060	570	740	1.48	1.71
April	2,950	530	772	1.54	1.72
May	3,240	510	1,010	2.02	2.33
June	1,720	410	585	1.17	1.30
July	11,600	530	1,680	3.36	3.87
August	3,420	530	1,200	2.40	2.77
September	6,000	490	819	1.64	1.83
October	2,950	490	608	1.22	1.41
November	510	450	485	.970	1.08
December	7,200	470	1,290	2.58	2.97
The year	11,600	215	903	1.81	24.59

Table II.—Estimated Monthly Discharge of Yadkin River at N. Wilkesboro, N. C.—*Con.*

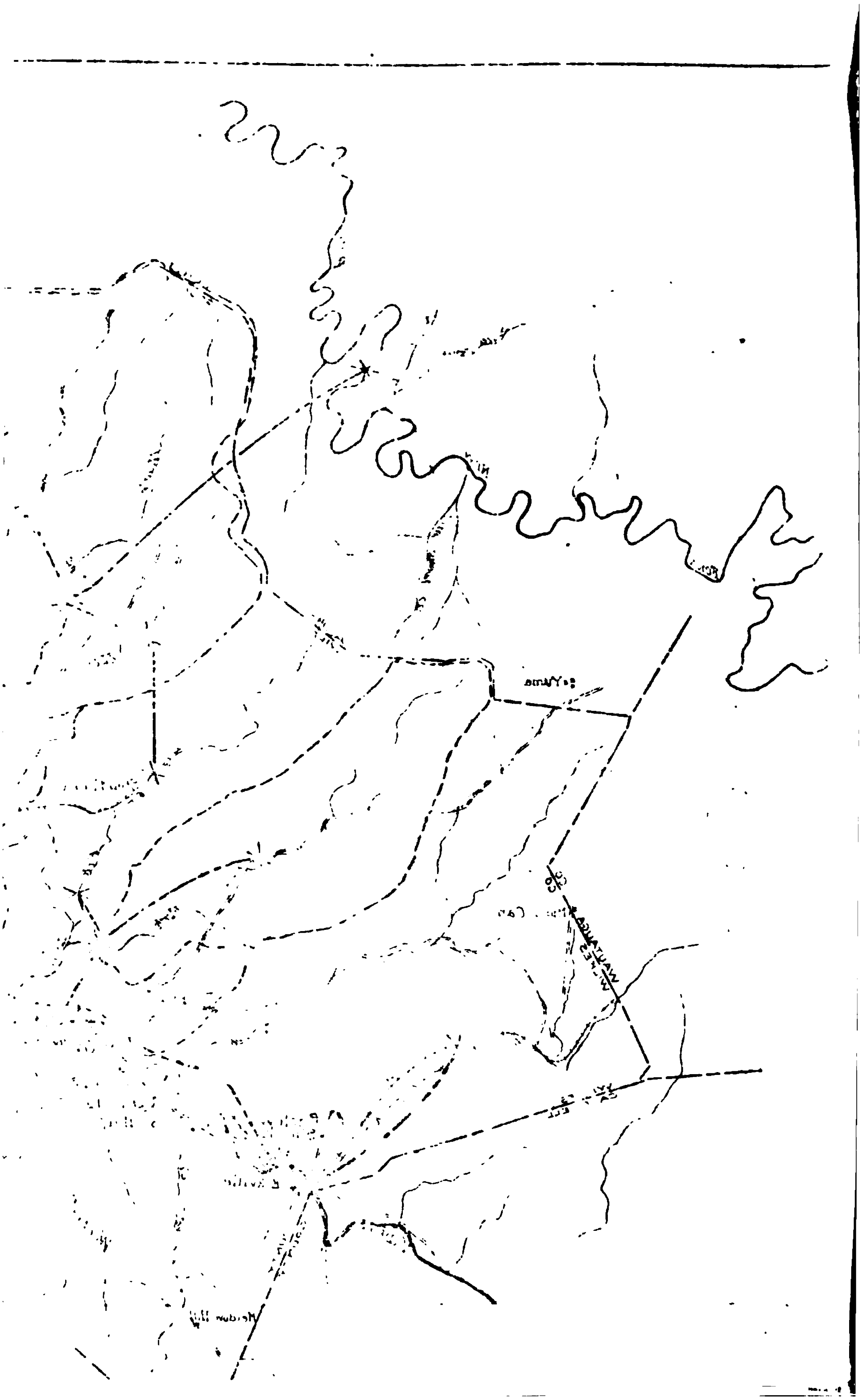
Month	Discharge in Second-feet			Run-off	
	Maximum	Minimum	Mean	Second-feet per Square Mile	Depth in Inches
1906					
January	11,400	677	2,160	4.32	4.98
February	1,690	840	1,020	2.04	2.12
March	3,710	840	1,460	2.92	3.37
April	3,330	865	1,230	2.46	2.74
May	3,900	677	986	1.97	2.27
June	6,500	677	1,840	3.68	4.11
July	4,100	815	1,550	3.10	3.57
August	17,100	972	2,900	5.80	6.69
September	5,700	1,340	2,110	4.22	4.71
October	17,000	1,720	3,270	6.54	7.54
November	17,900	1,440	2,520	5.04	5.62
December	6,700	1,120	1,710	3.42	3.94
The year	17,900	677	1,900	3.79	51.66
1907					
January	3,710	1,080	1,480	2.96	3.41
February	1,440	890	1,040	2.08	2.17
March	2,310	835	1,180	2.36	2.72
April	3,520	862	1,320	2.64	2.94
May	1,250	755	945	1.89	2.18
June	8,000	920	1,940	3.88	4.33
July	1,820	705	982	1.96	2.26
August	1,080	590	716	1.43	1.65
September	8,500	510	985	1.97	2.20
October	680	490	546	1.09	1.26
November	3,140	490	778	1.56	1.74
December	7,700	550	1,570	3.14	3.62
The year	8,500	490	1,120	2.25	30.48

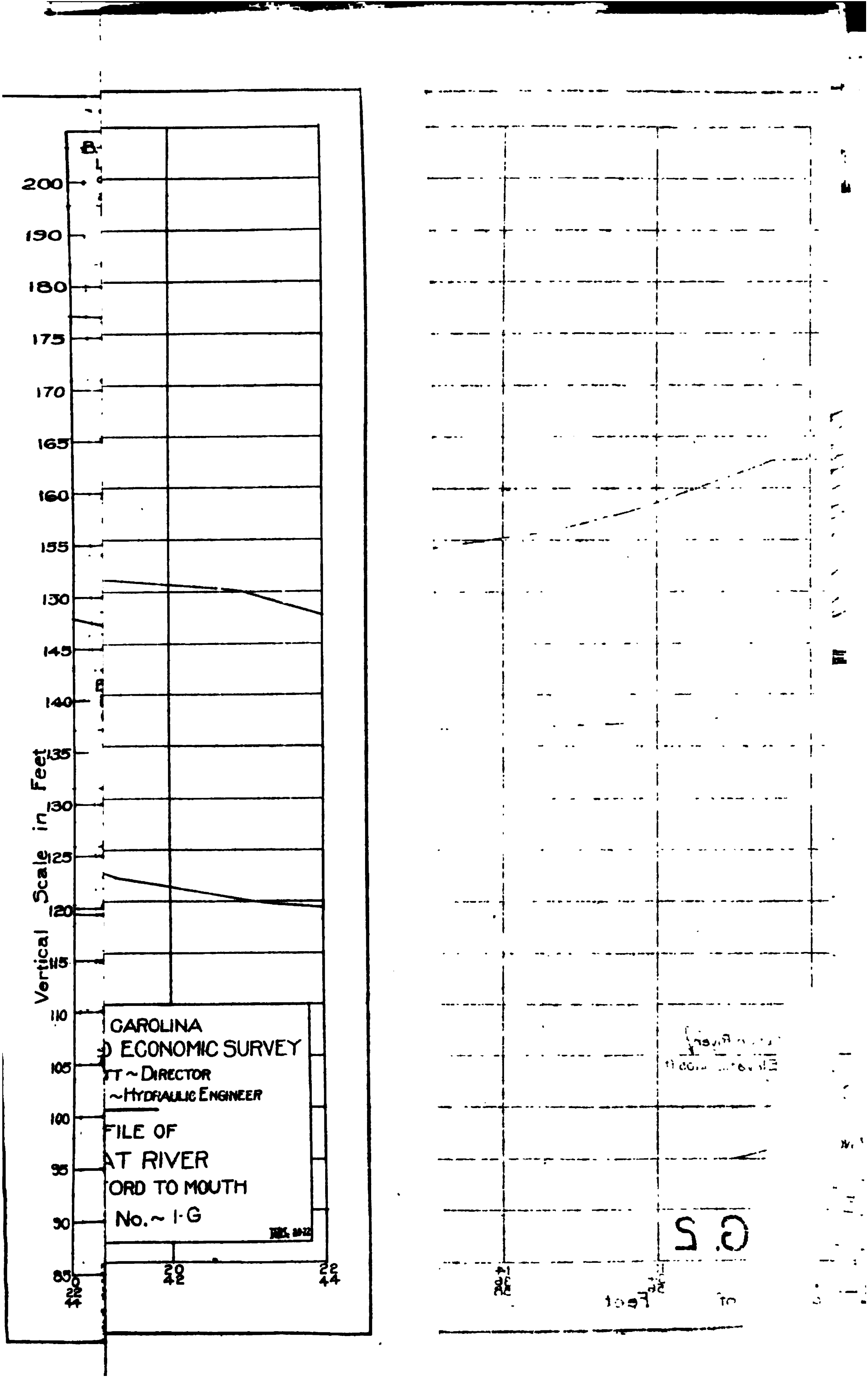
Note.—Discharge above 4,000 second-feet approximate.

FIG. I

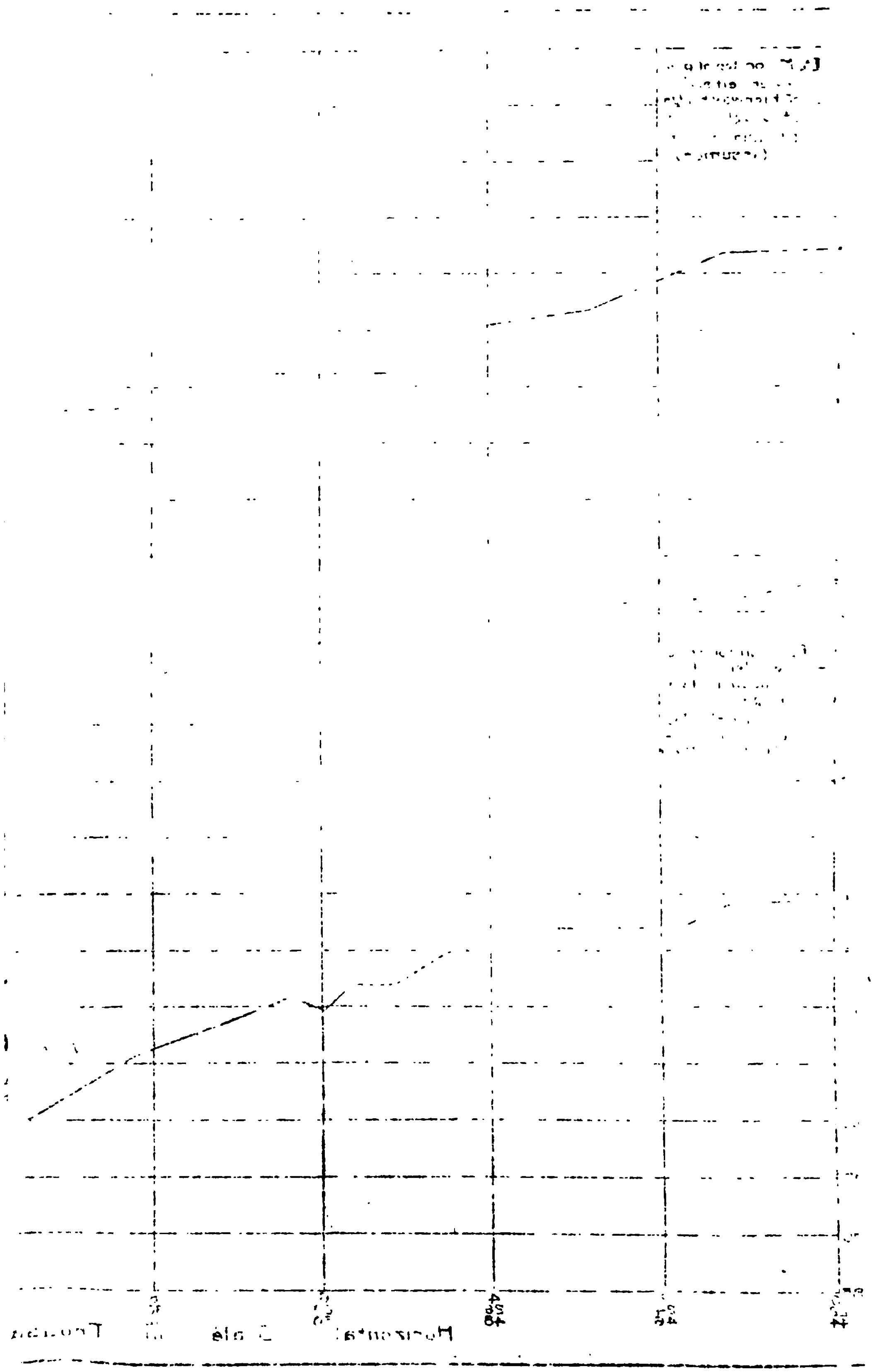


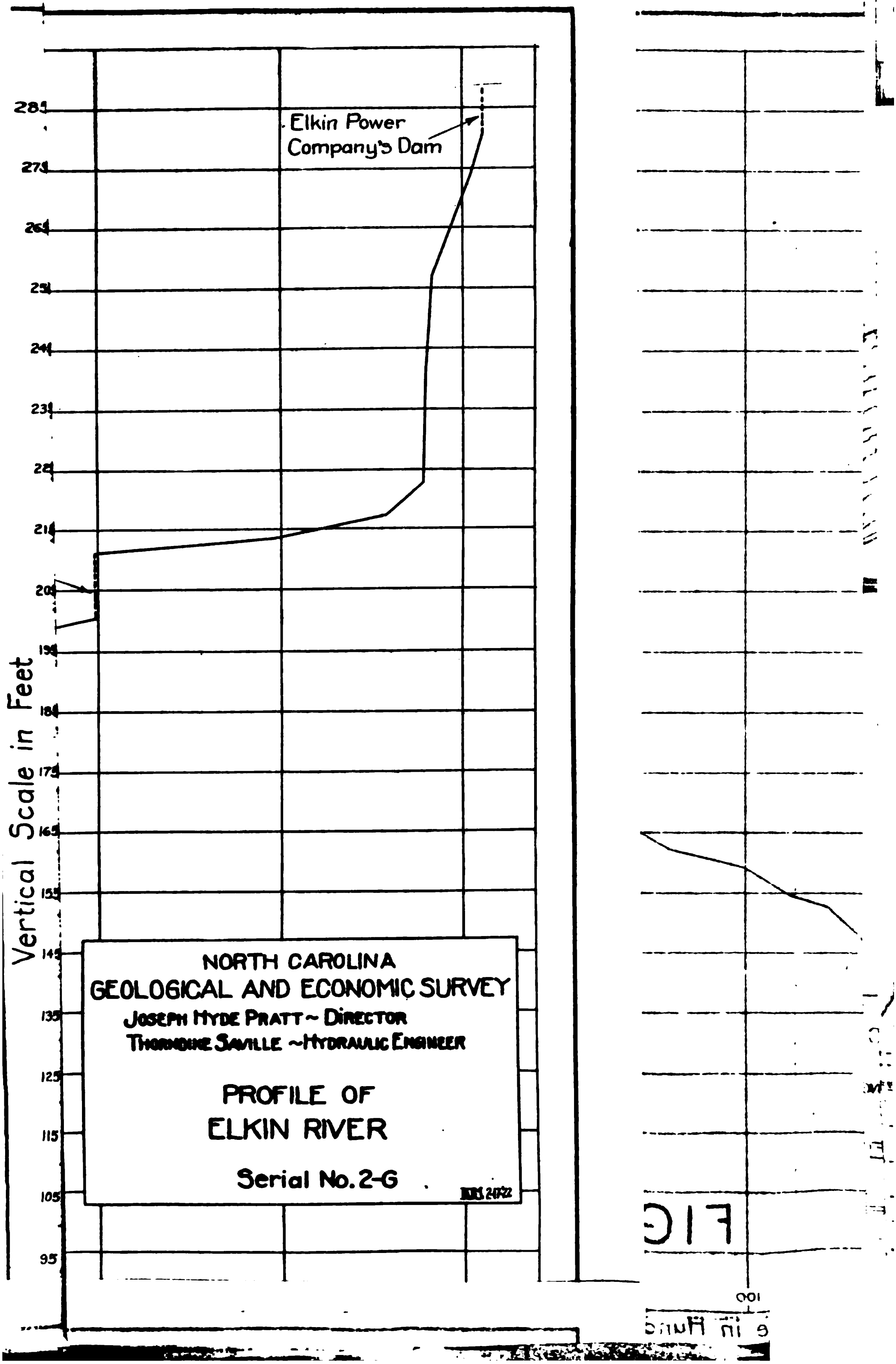
Elkin
TRANSMISSION LINE TO
SURRY COUNTY POWERS
WILKES
SURRY
NORTH CAROLINA
GEOLOGICAL AND ECONOMIC SURVEY

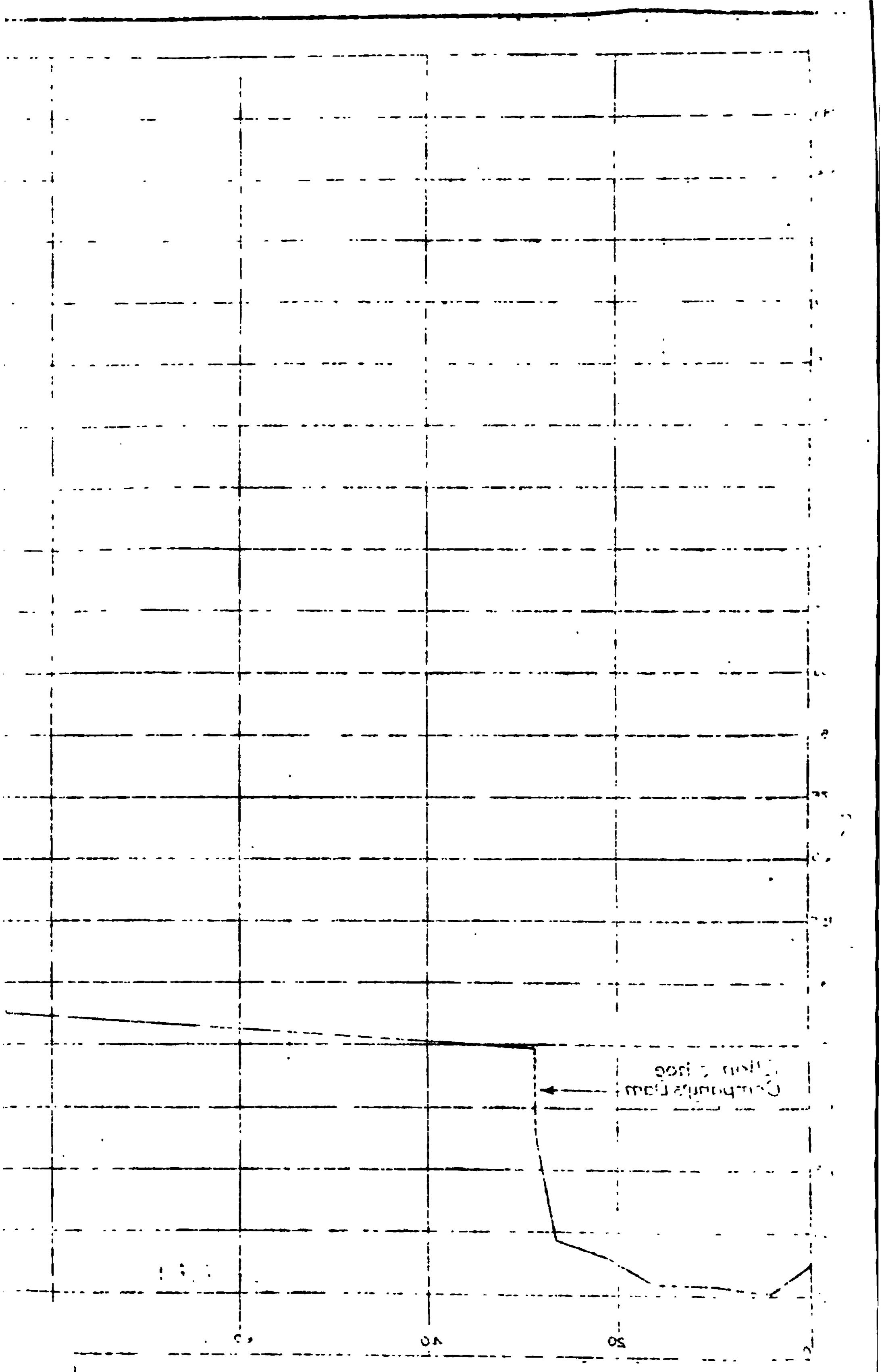


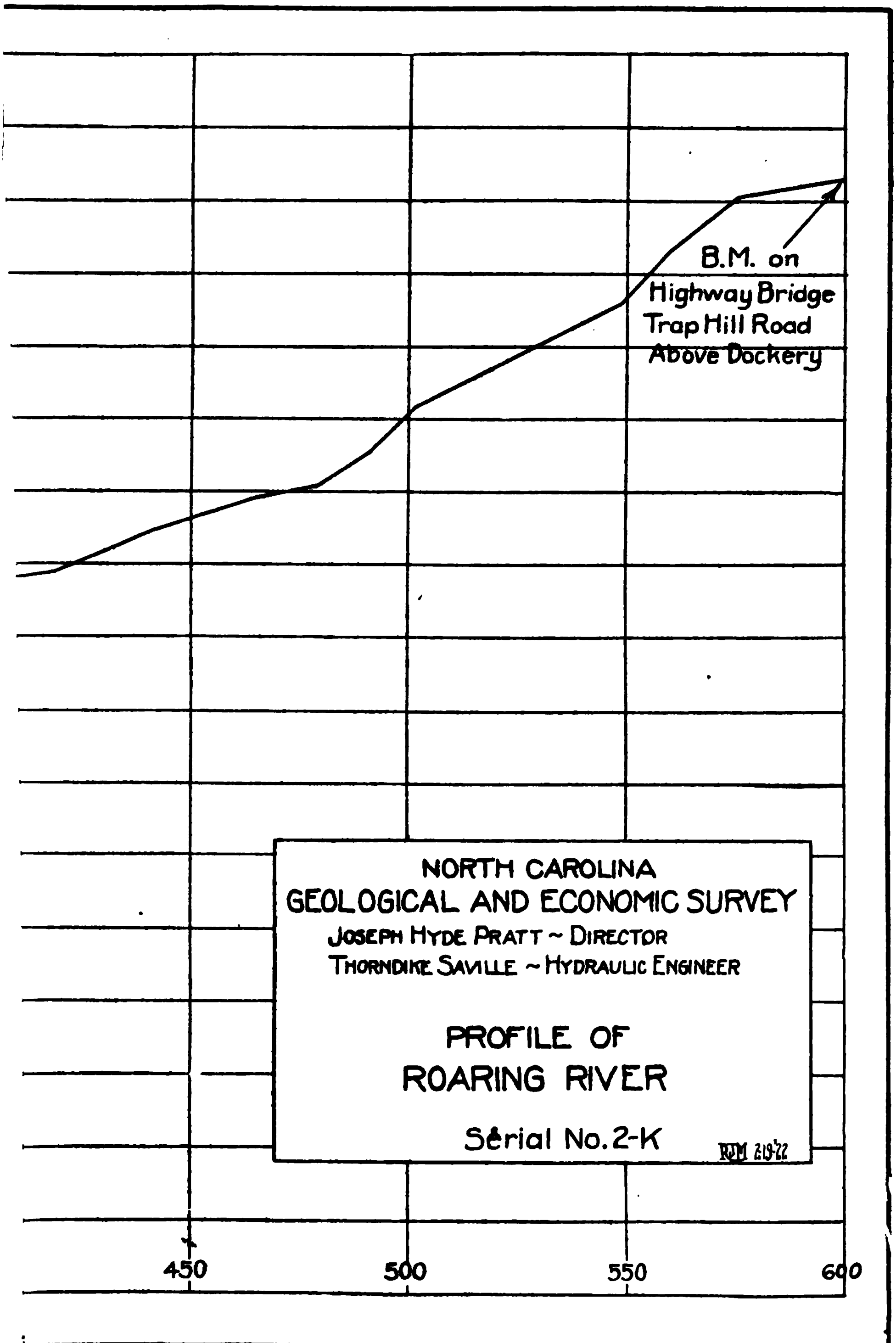


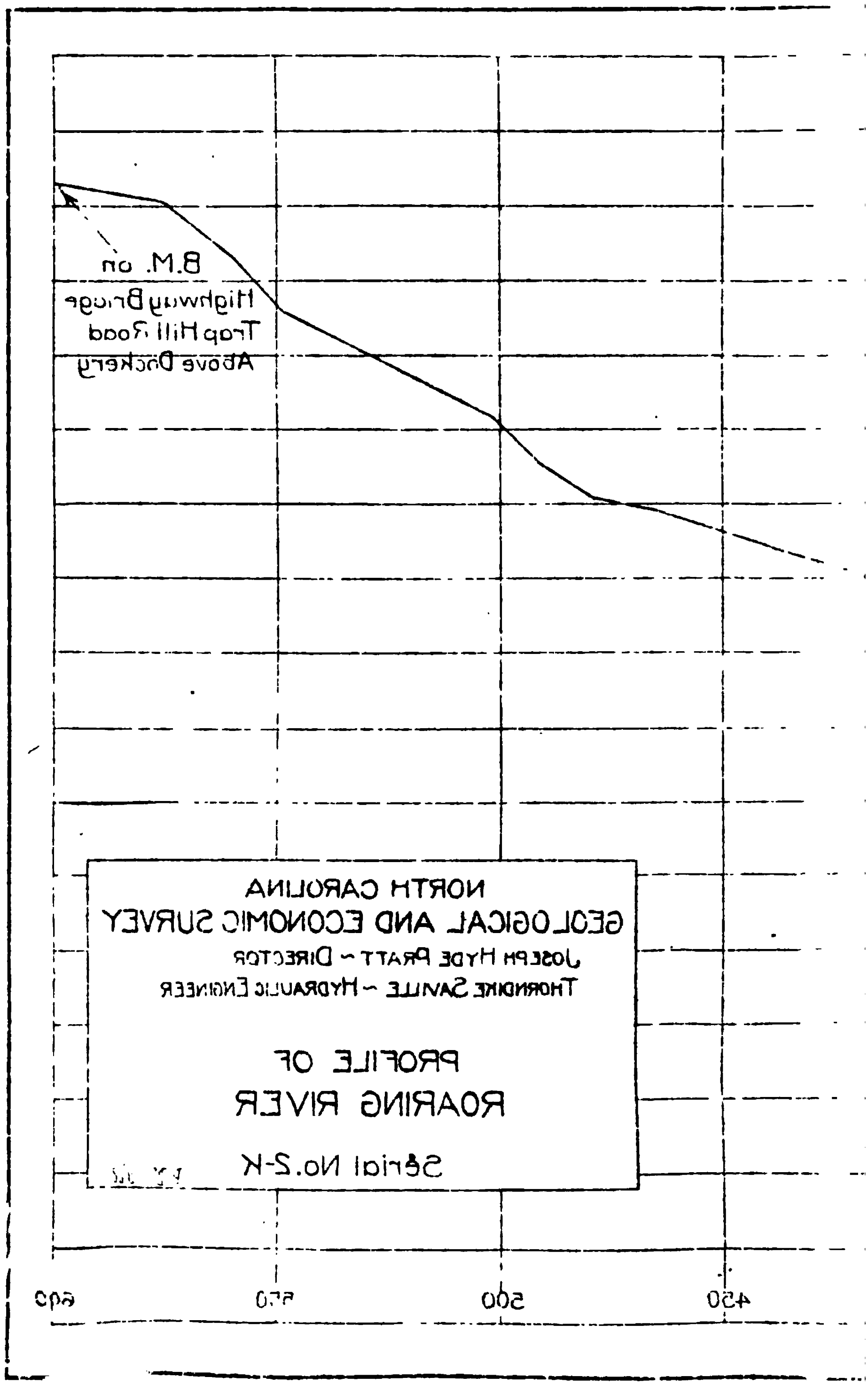
200
190
180
175
170
165
160
155
150
145
140
135
130
125
120
115
110
105
100
95
90
85
Vertical Scale in Feet
CAROLINA
D ECONOMIC SURVEY
TT ~ DIRECTOR
~ HYDRAULIC ENGINEER
FILE OF
AT RIVER
ORD TO MOUTH
No. ~ 1-G
0
20
22




Elkin Power Company's Dam
Vertical Scale in Feet
285
275
265
255
245
235
225
215
205
195
185
175
165
155
145
135
125
115
105
95
NORTH CAROLINA
GEOLOGICAL AND ECONOMIC SURVEY
JOSEPH HYDE PRATT ~ DIRECTOR
THORNDIKE SAVILLE ~ HYDRAULIC ENGINEER
PROFILE OF
ELKIN RIVER
Serial No. 2-G




B.M. on
Highway Bridge
Trap Hill Road
Above Dockery
NORTH CAROLINA
GEOLOGICAL AND ECONOMIC SURVEY
JOSEPH HYDE PRATT ~ DIRECTOR
THORNDIKE SAVILLE ~ HYDRAULIC ENGINEER
PROFILE OF
ROARING RIVER
Serial No. 2-K
RJM 2-19-22
450
500
550
600


B.M. on
Highway Bridge
Trap Hill Road
Above Dockery
NORTH CAROLINA
GEOLOGICAL AND ECONOMIC SURVEY
Joseph Hyde Pratt – Director
Thorndike Saville – Hydraulic Engineer
PROFILE OF
ROARING RIVER
Serial No. 2-K
600
550
500
450

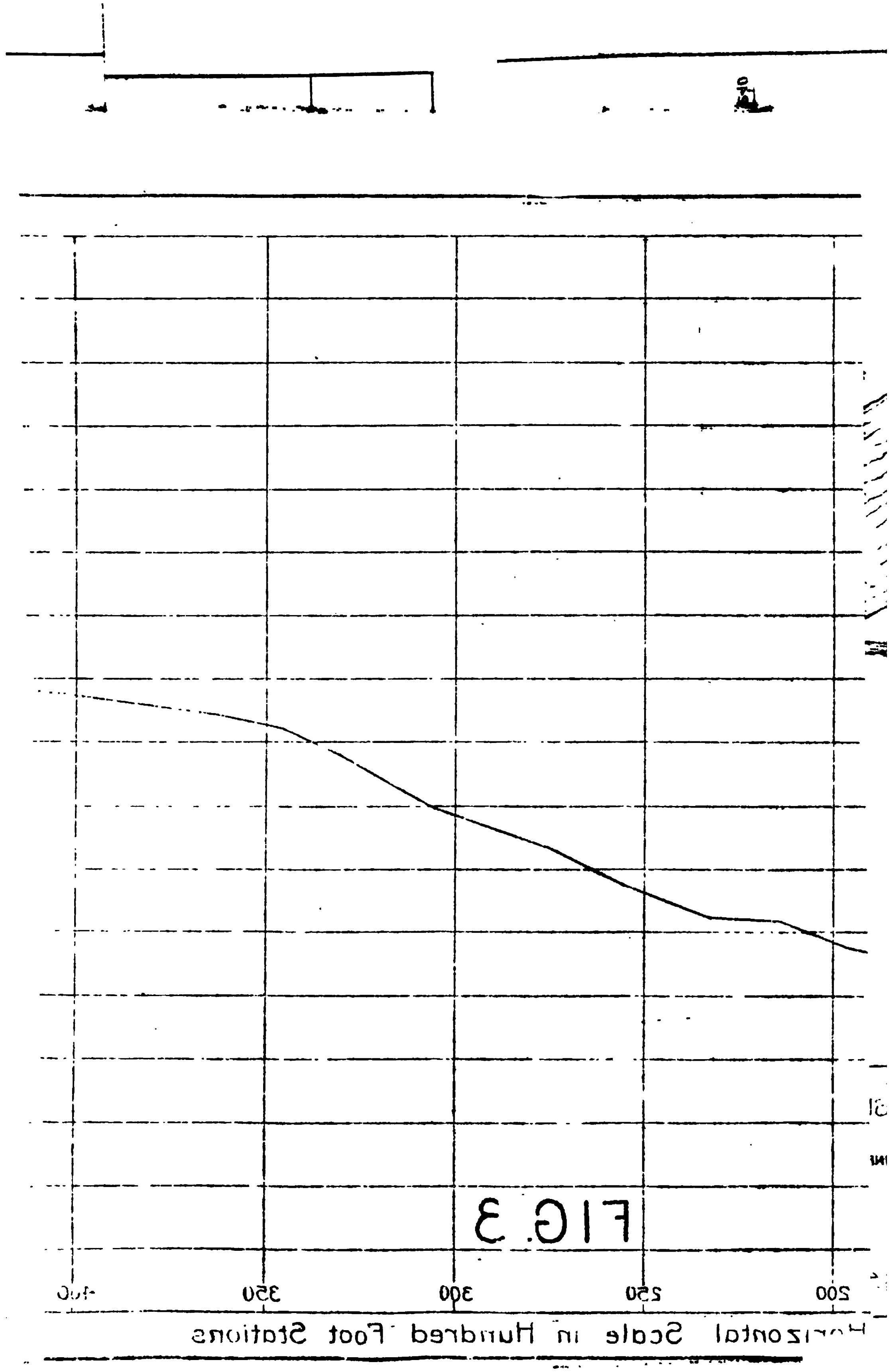
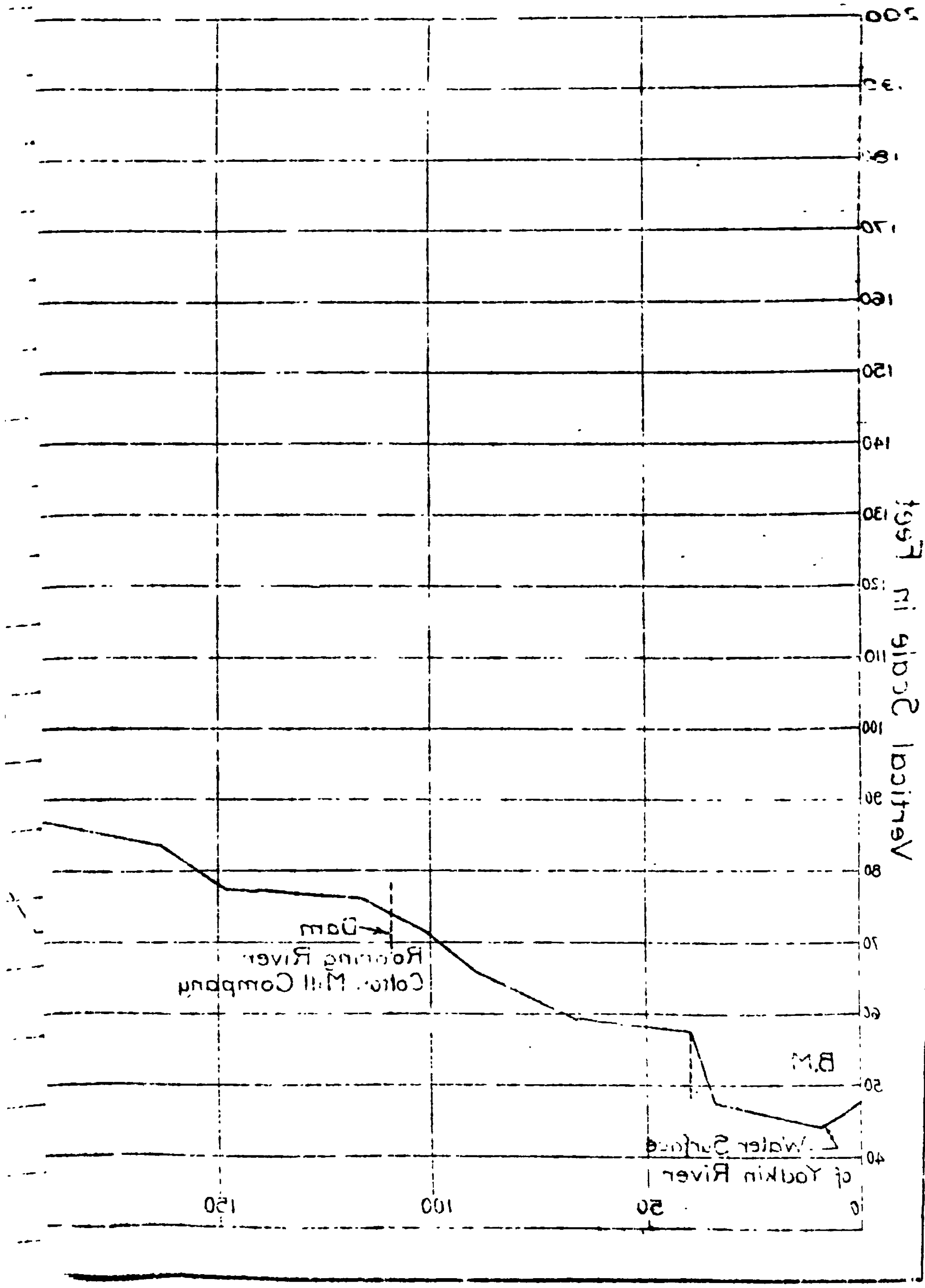
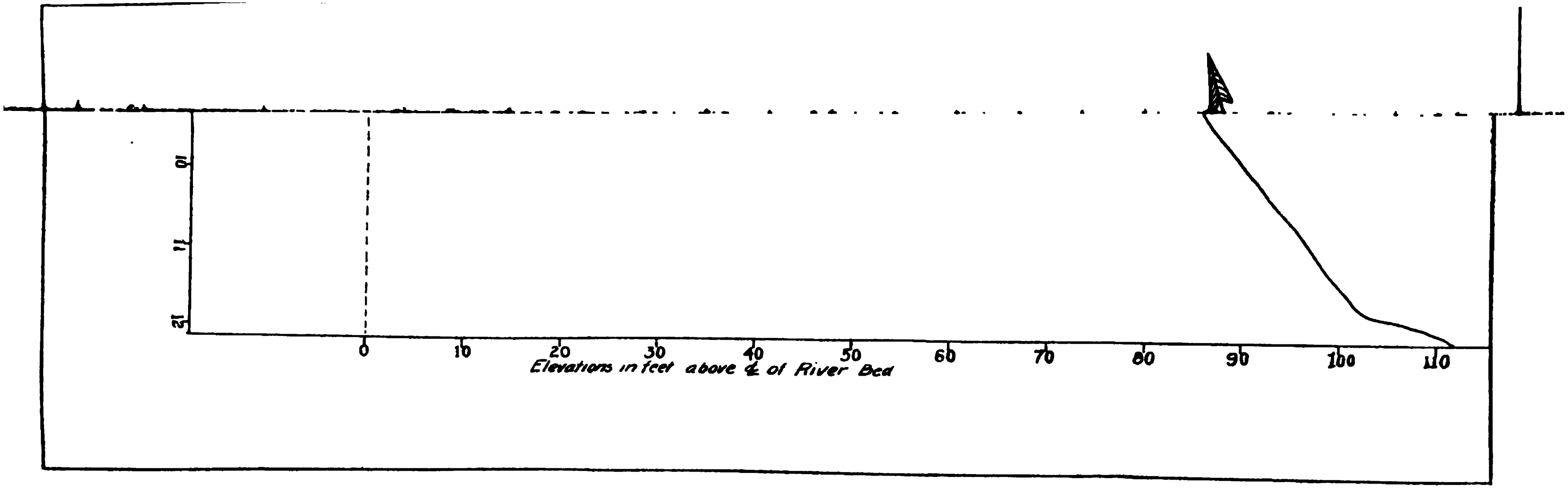
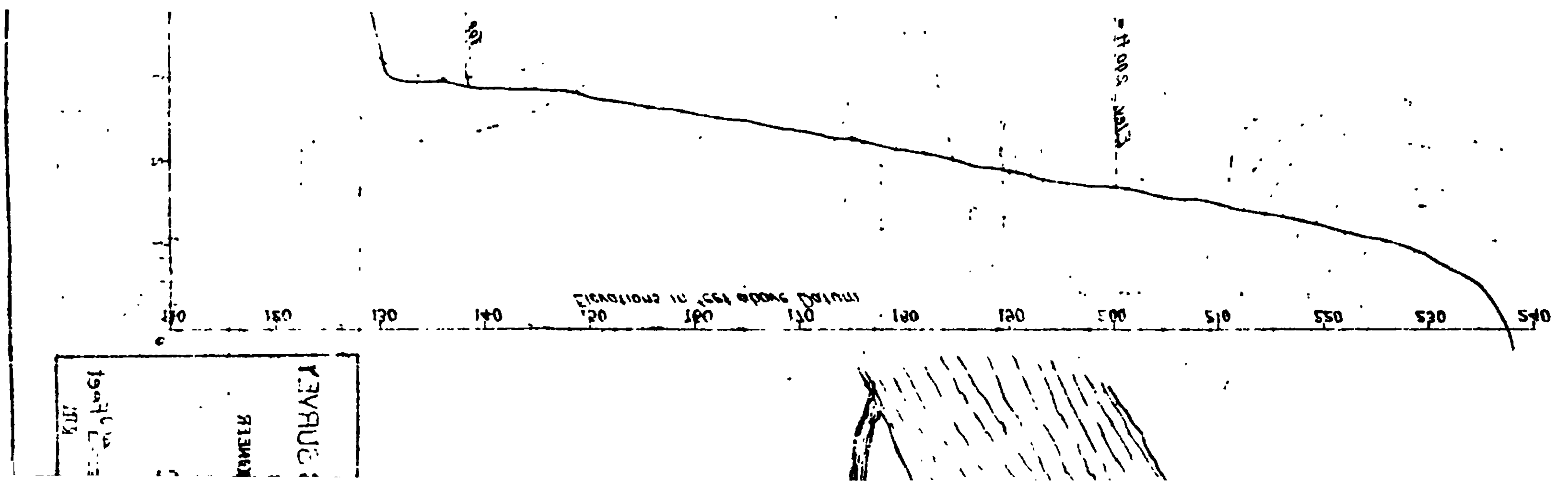

400
350
300
250
200
Horizontal Scale in Hundred Foot Stations

FIG. 3



Vertical Scale in Feet
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
Dam
Rolling River
Cotton Mill Company
B.M.
Water Surface
of Yadkin River
150
100
50
0


10
11
12
0
10
20
30
40
50
60
70
80
90
100
110
Elevations in feet above ℄ of River Bed



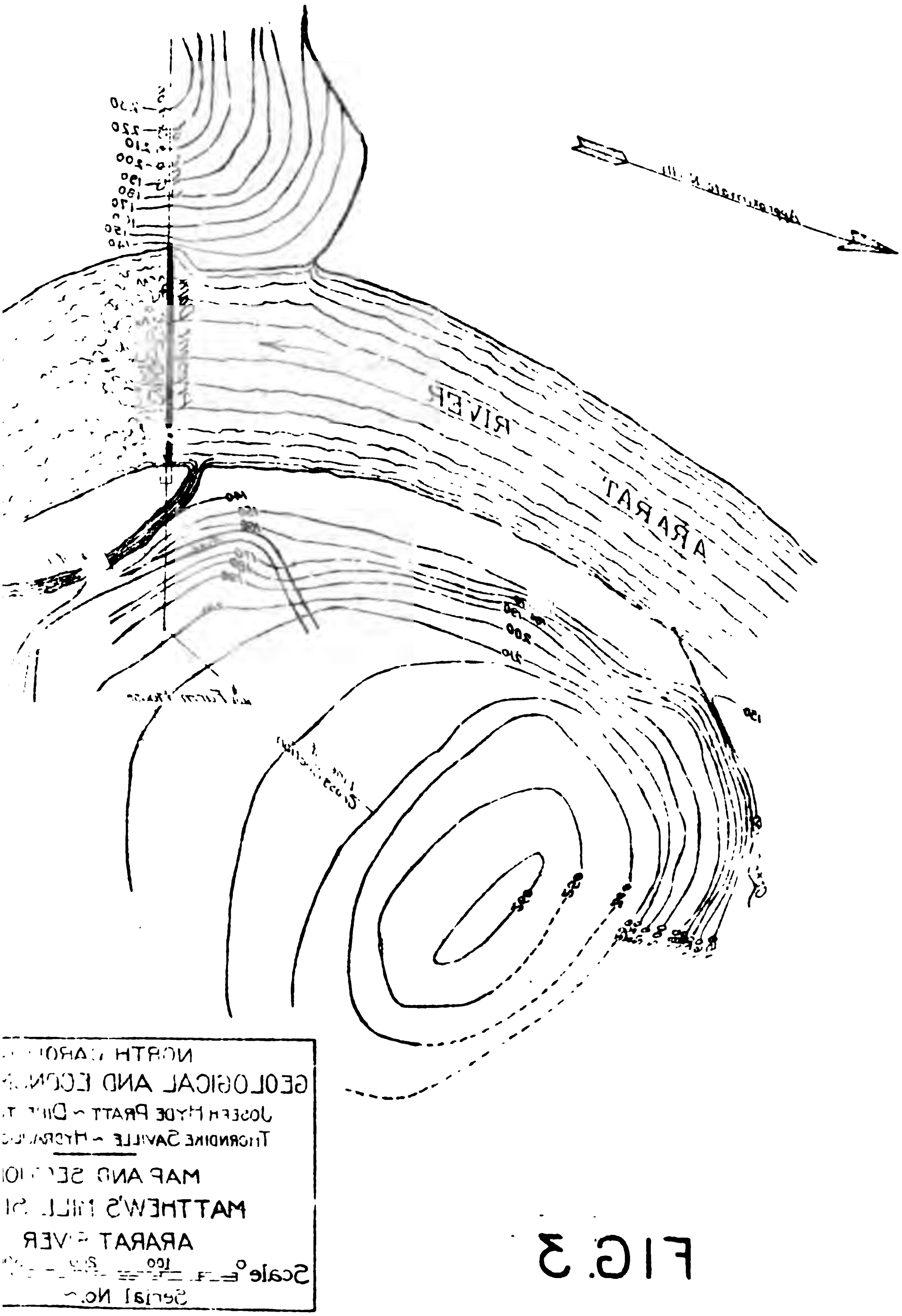
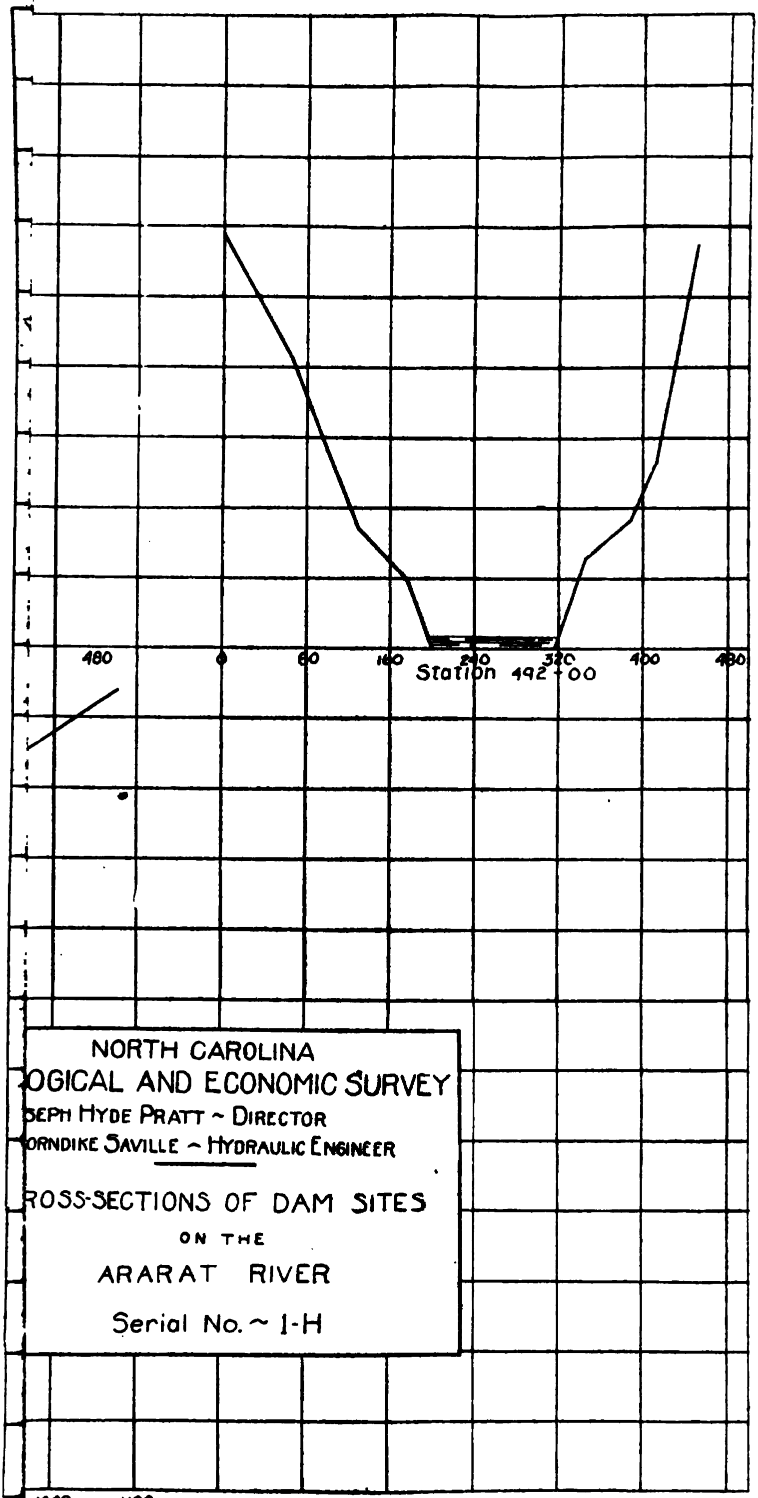

ARARAT RIVER
GEOLOGICAL AND ECON
MAP AND SEC
MATTHEW'S MILL
ARARAT
Scale
Serial No.

FIG. 3



NORTH CAROLINA
OGICAL AND ECONOMIC SURVEY
SEPH HYDE PRATT ~ DIRECTOR
ORNDIKE SAVILLE ~ HYDRAULIC ENGINEER

ROSS-SECTIONS OF DAM SITES
ON THE
ARARAT RIVER

Serial No. ~ 1-H

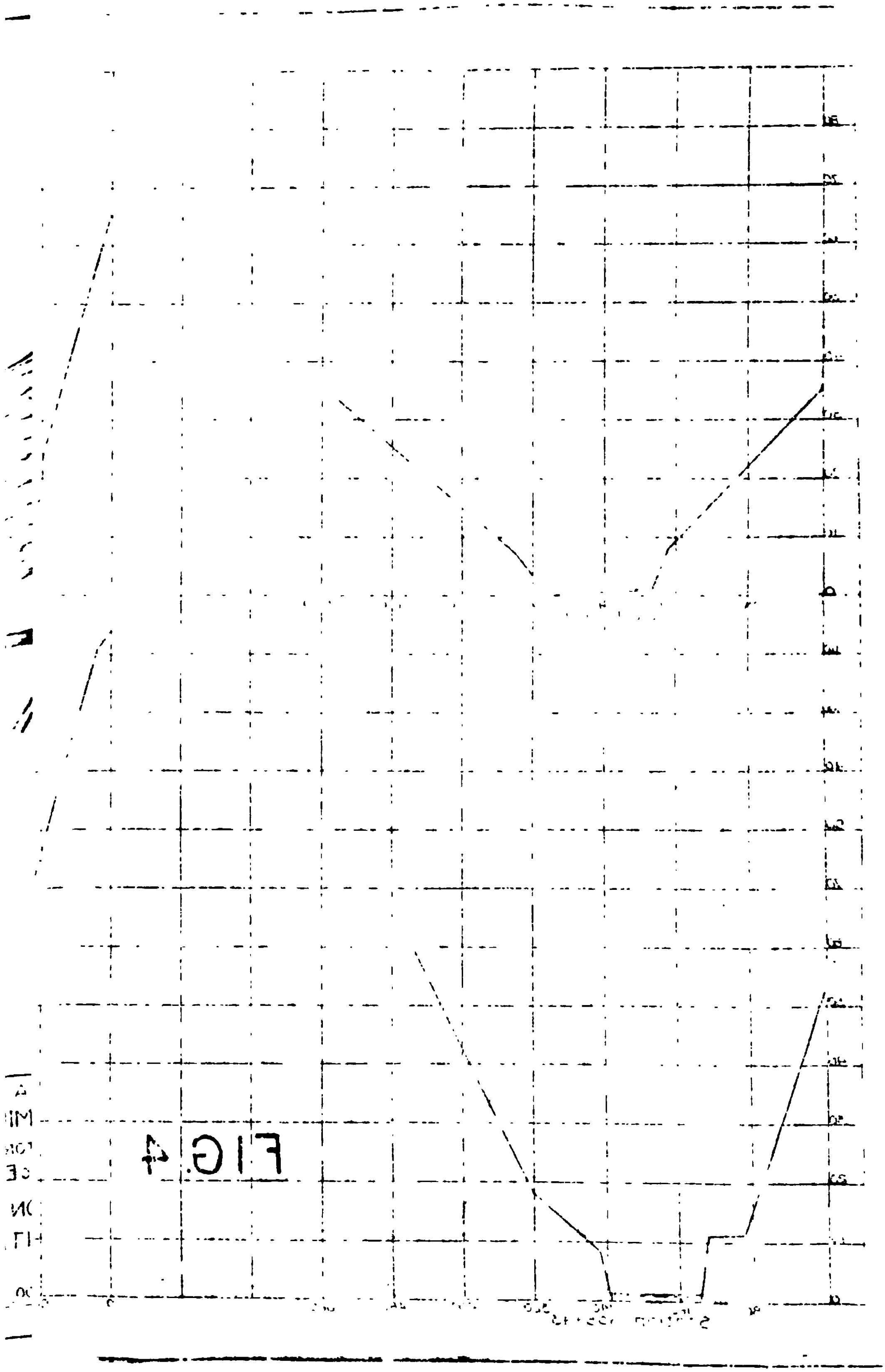
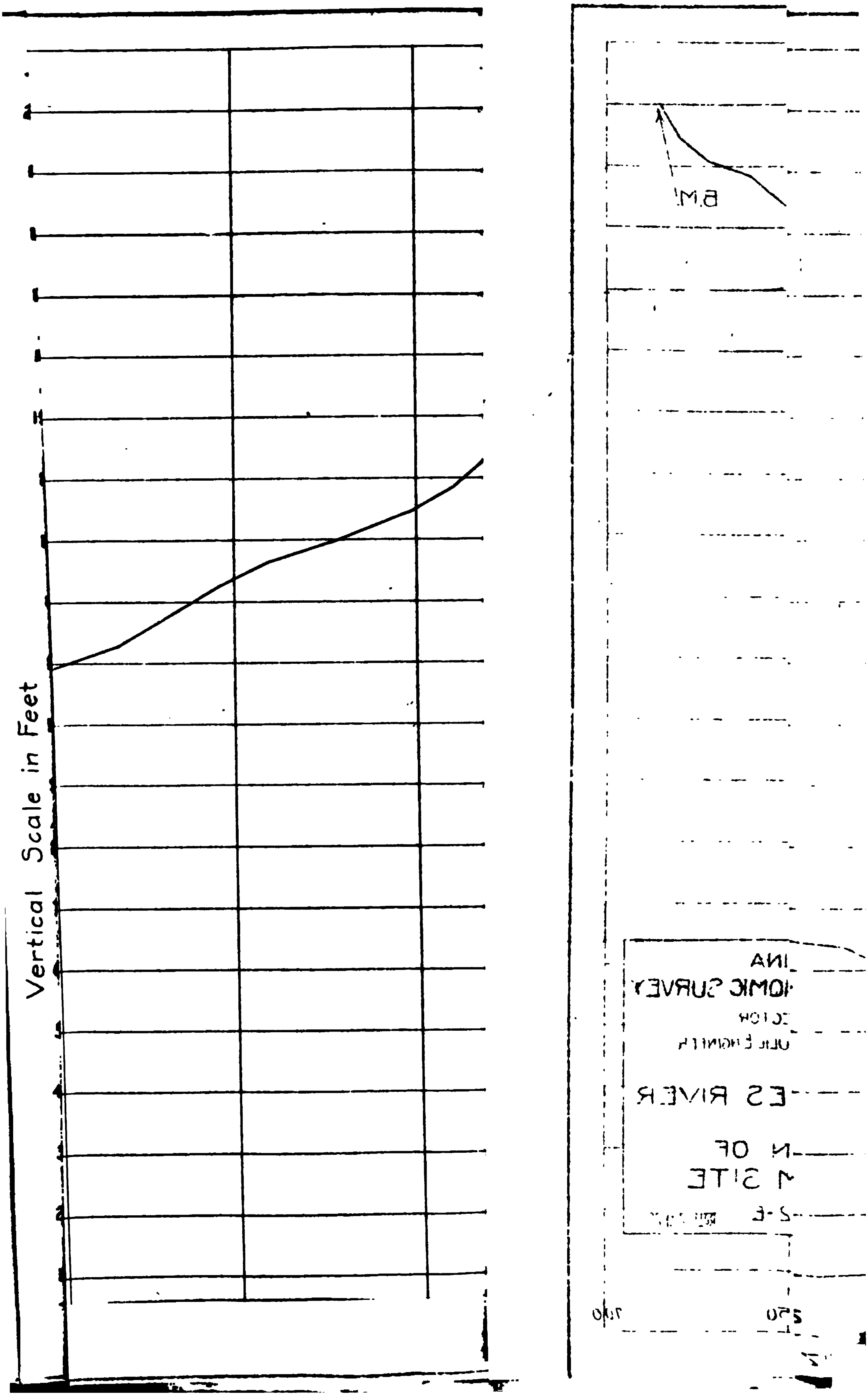
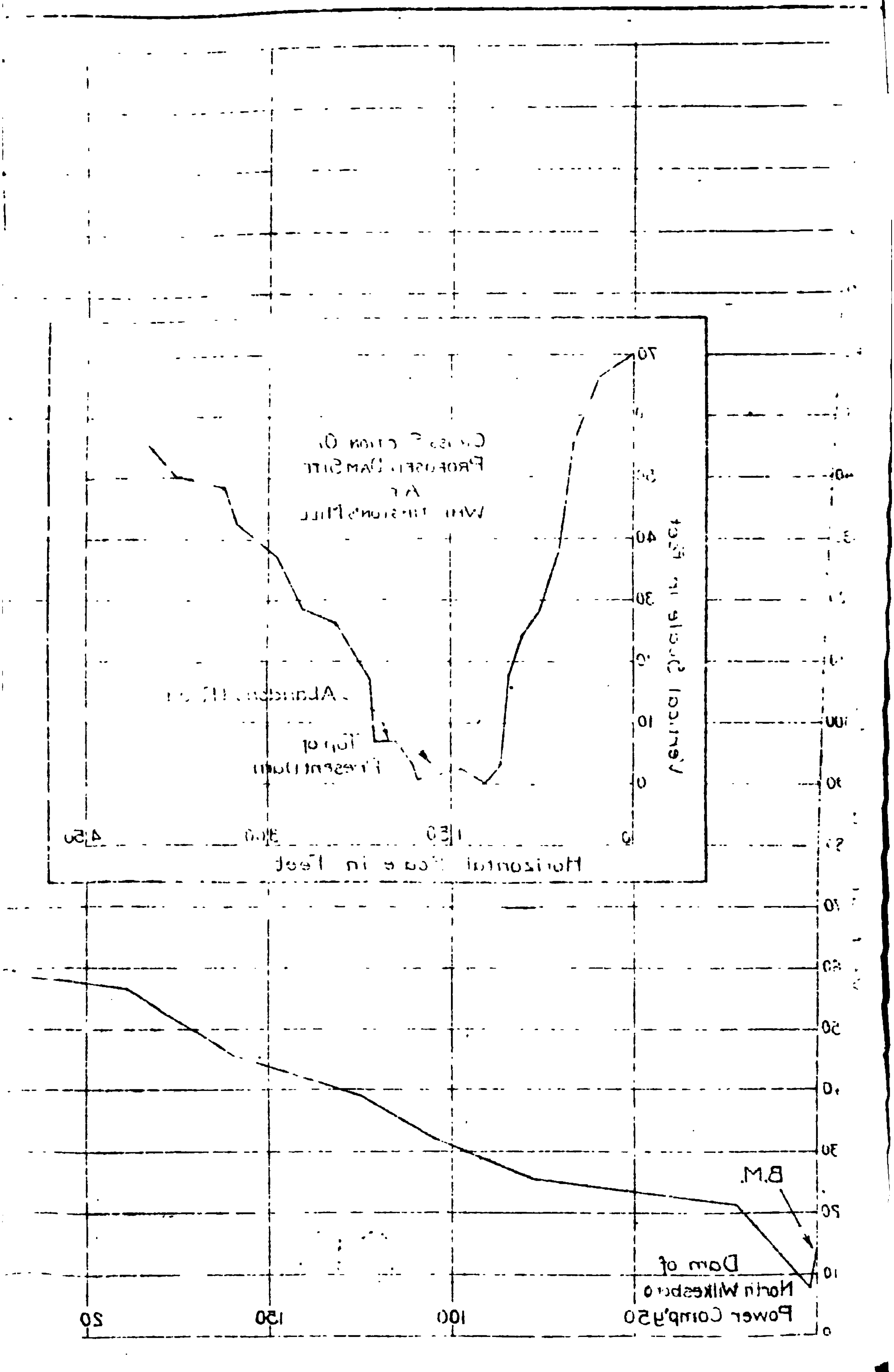
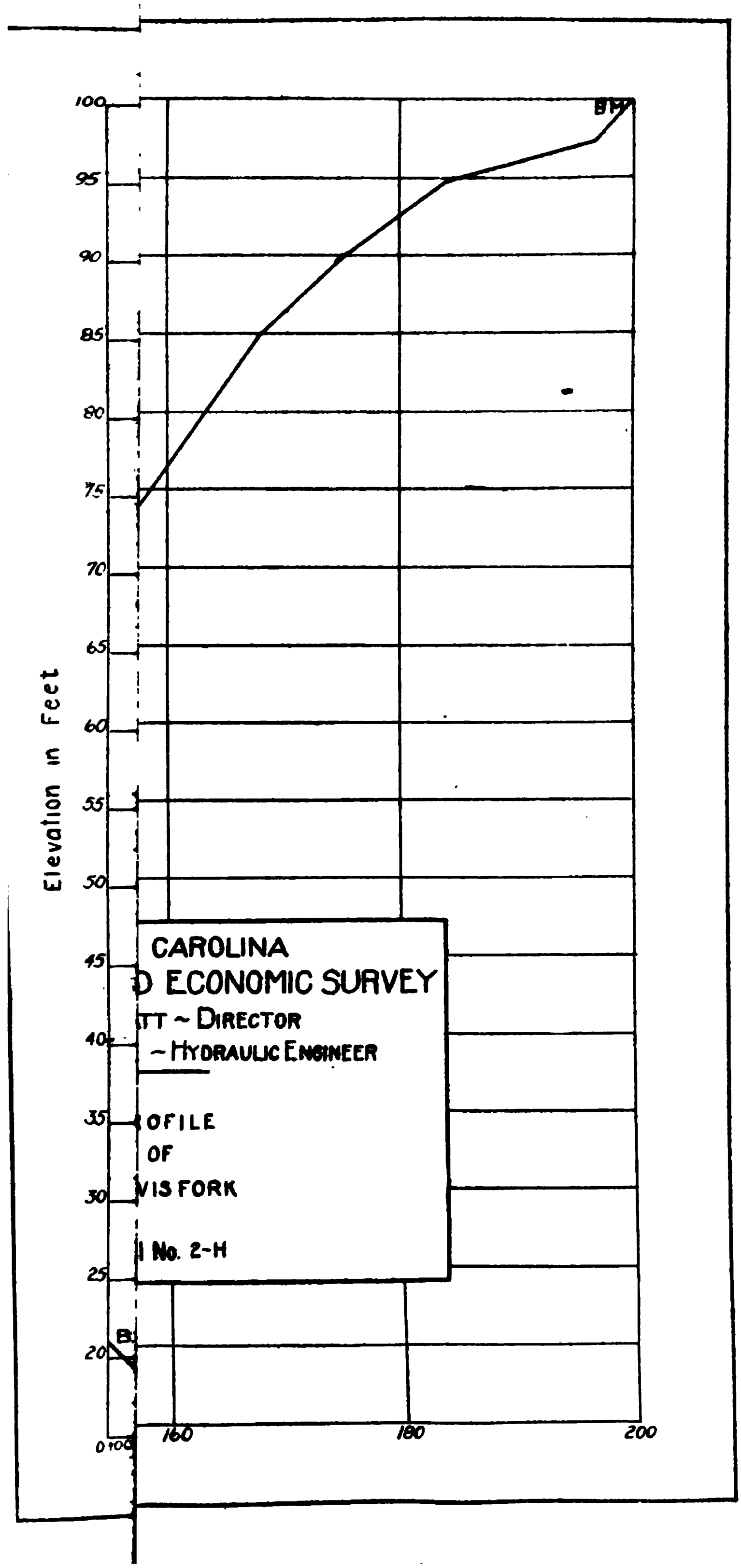


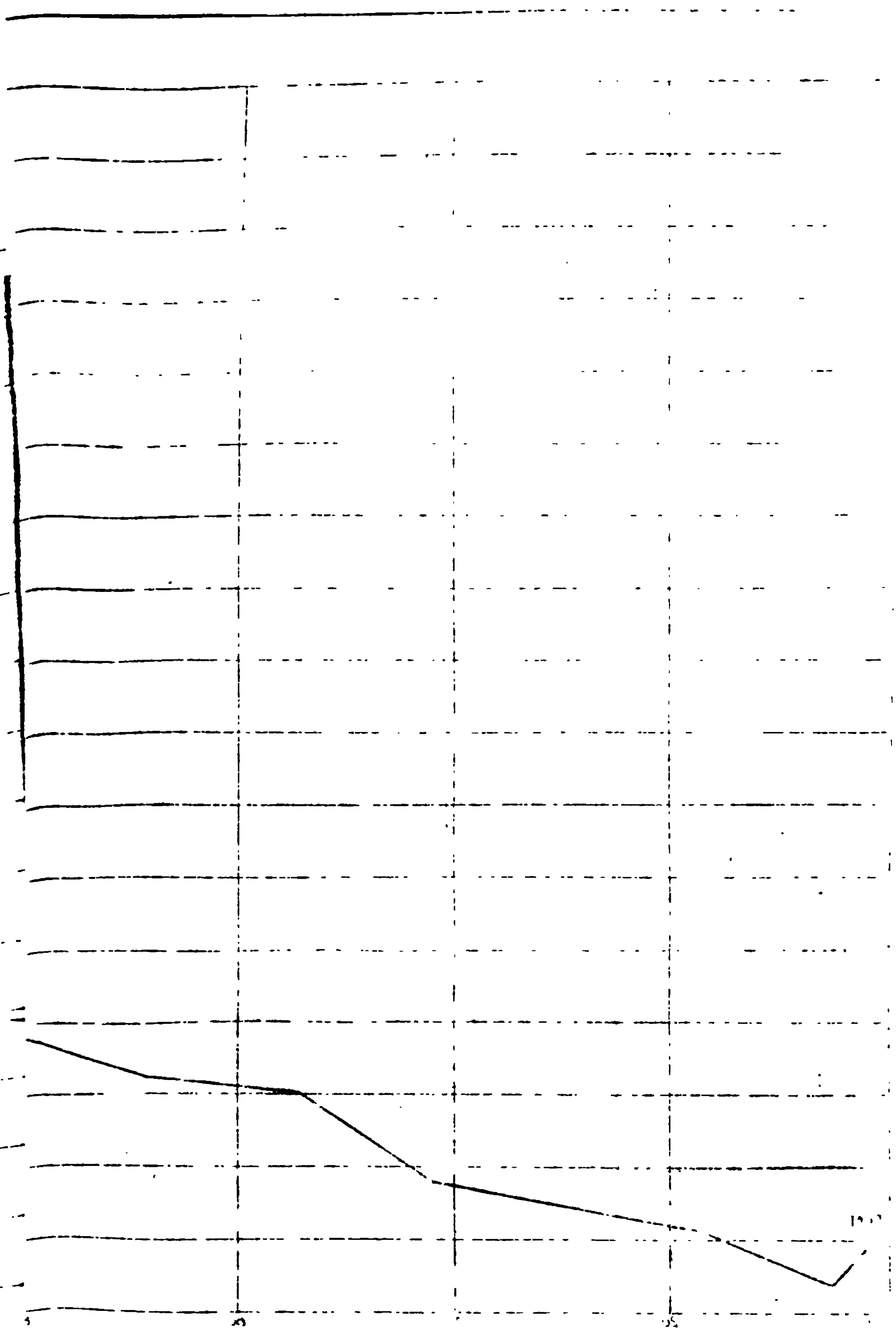
FIG. 4

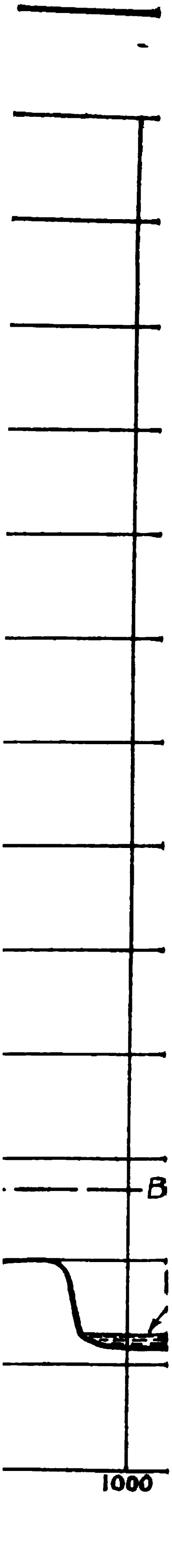

Vertical Scale in Feet

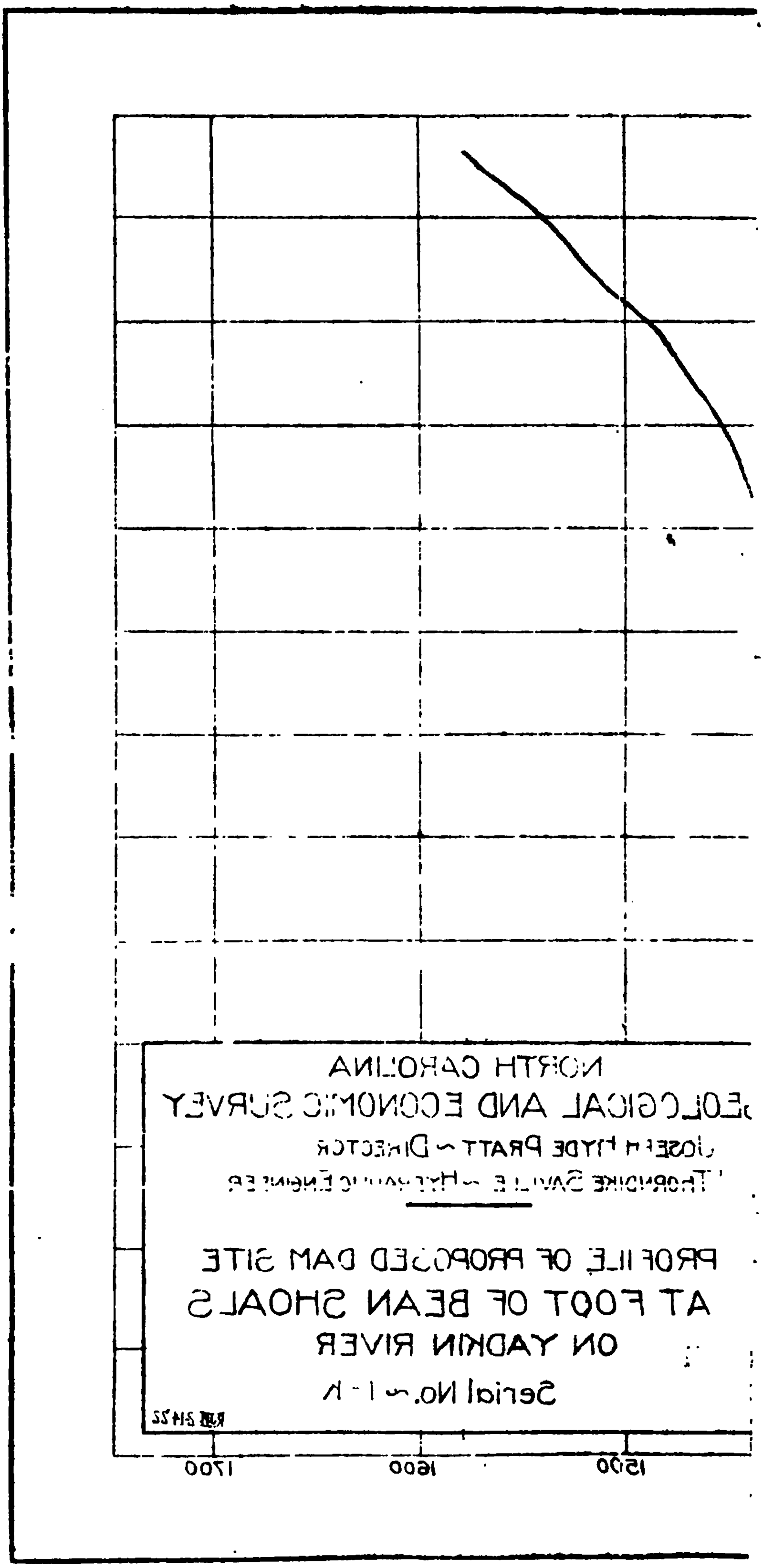


Cross Section Of
Proposed Dam Site
At
Top of
Present Dam
Vertical Scale in Feet
Horizontal Scale in Feet
B.M.
Dam of
North Wilkesboro
Power Comp'y


Elevation in Feet
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
BM
160
180
200
CAROLINA
D ECONOMIC SURVEY
TT ~ DIRECTOR
~ HYDRAULIC ENGINEER
OFILE
OF
VIS FORK
No. 2-H




B
1000


NORTH CAROLINA
GEOLOGICAL AND ECONOMIC SURVEY
JOSEPH HYDE PRATT ~ DIRECTOR
THORNDIKE SAVILLE ~ HYDRAULIC ENGINEER
PROFILE OF PROPOSED DAM SITE
AT FOOT OF BEAN SHOALS
ON YADKIN RIVER
Serial No. ~ 1 - A
1700
1600
1500

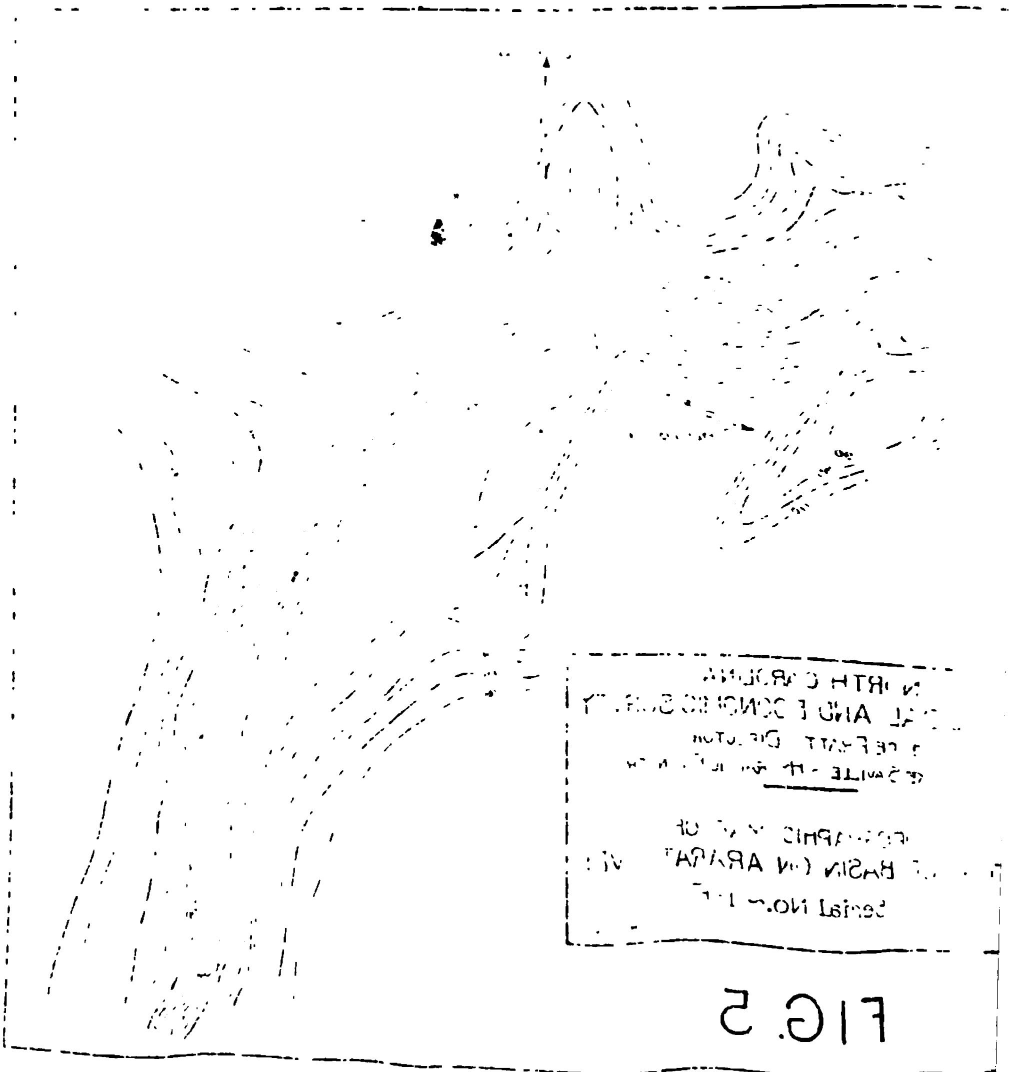
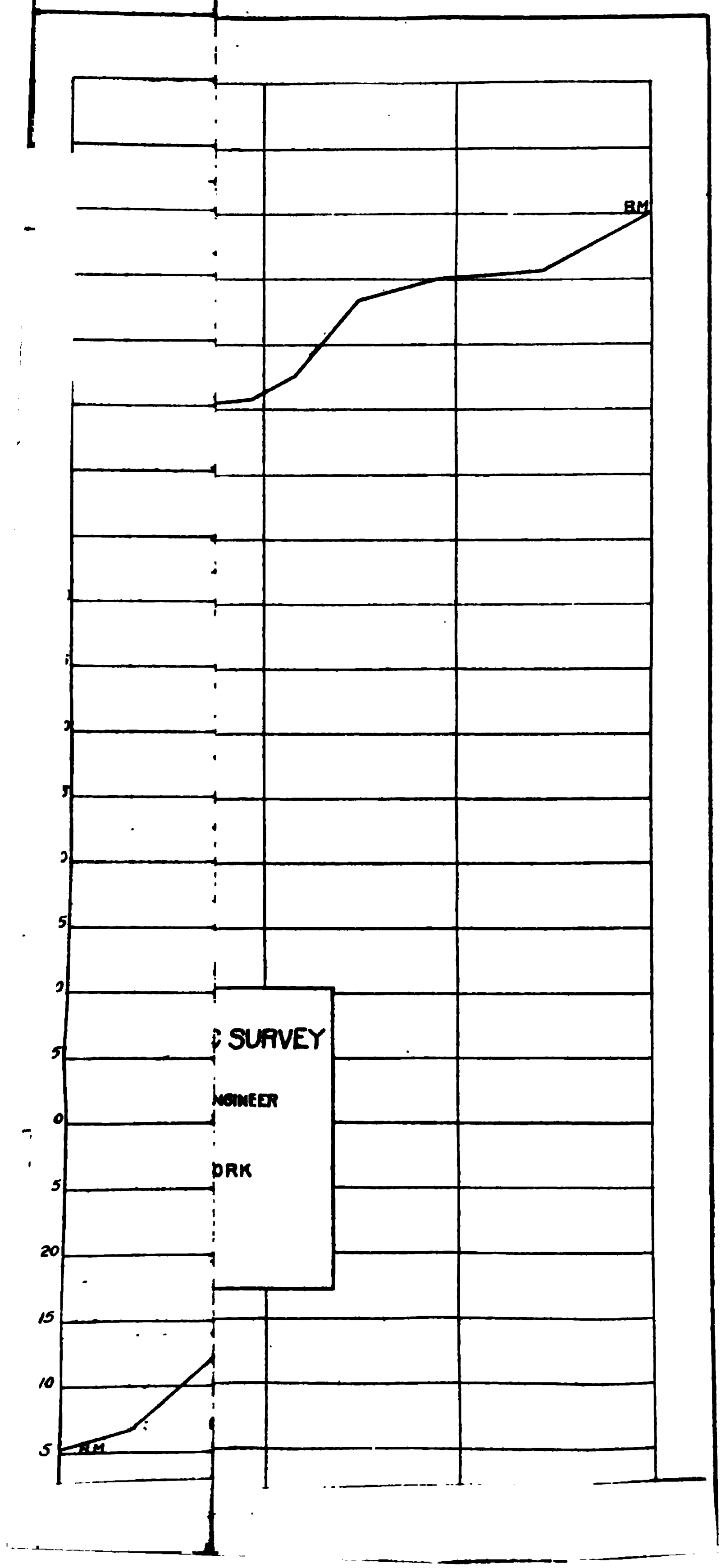
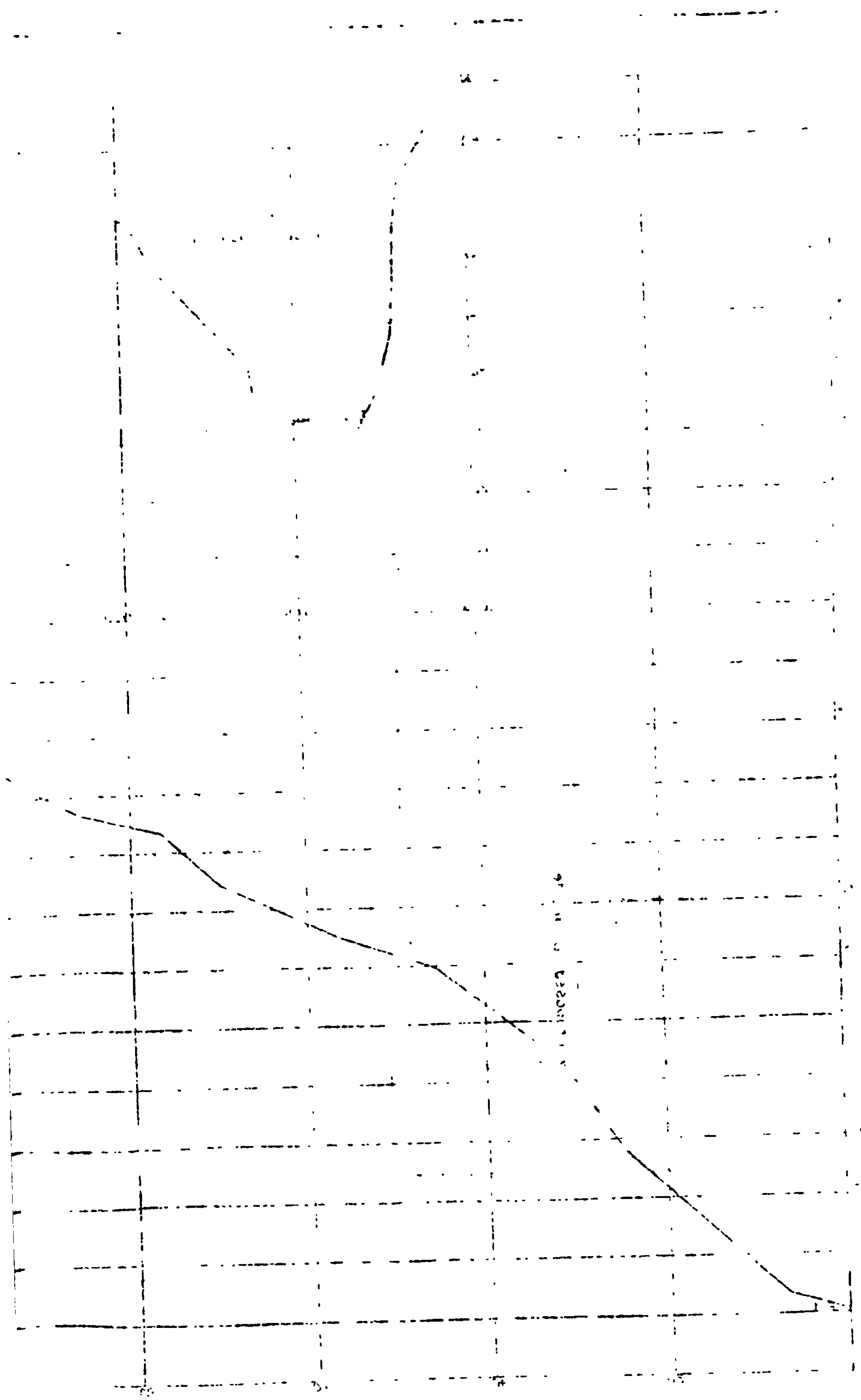
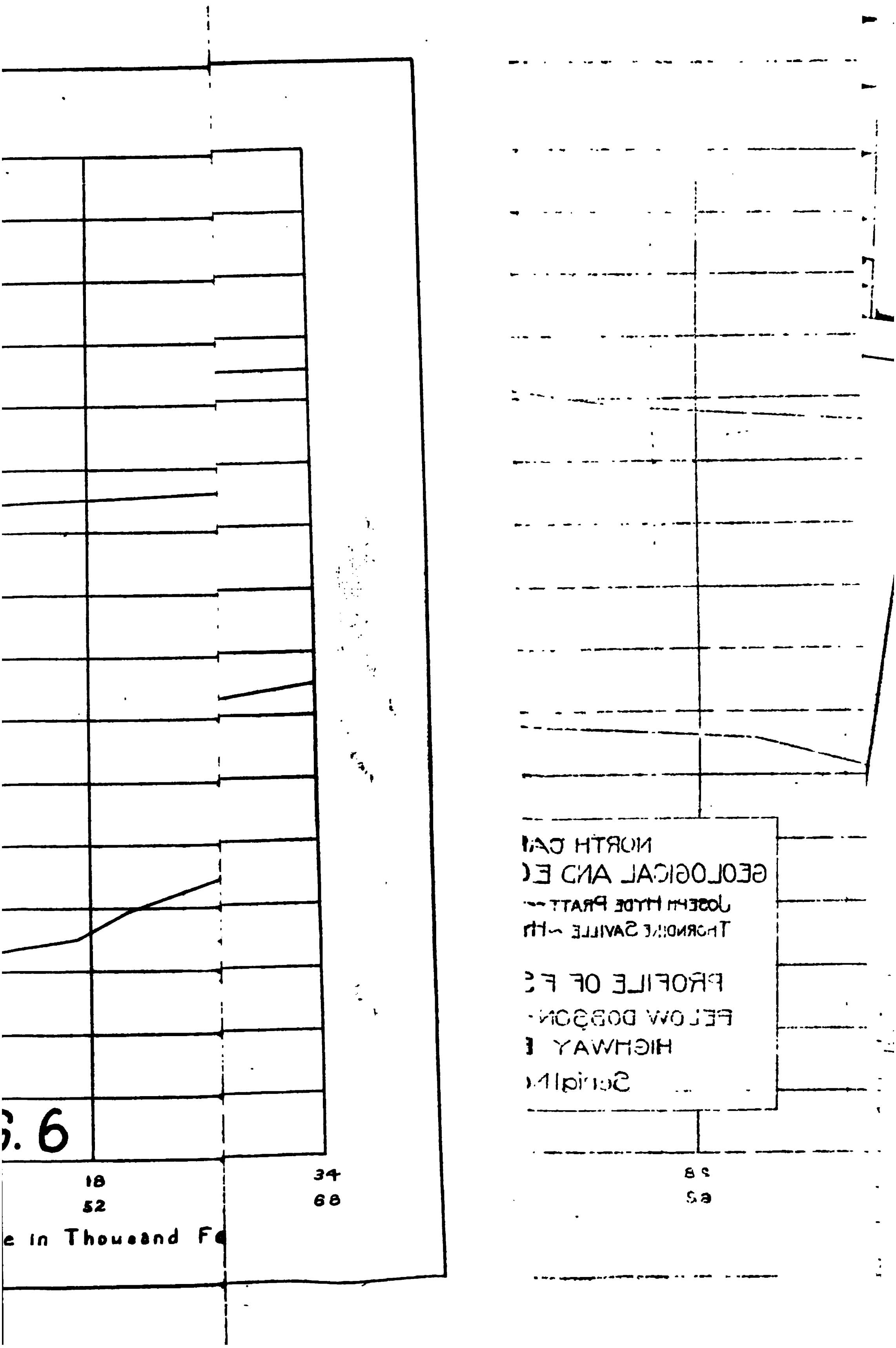

NORTH CAROLINA
AL AND ECONOMIC SURVEY
PRATT, Director
TOPOGRAPHIC MAP OF
BASIN ON ARARAT
Serial No.

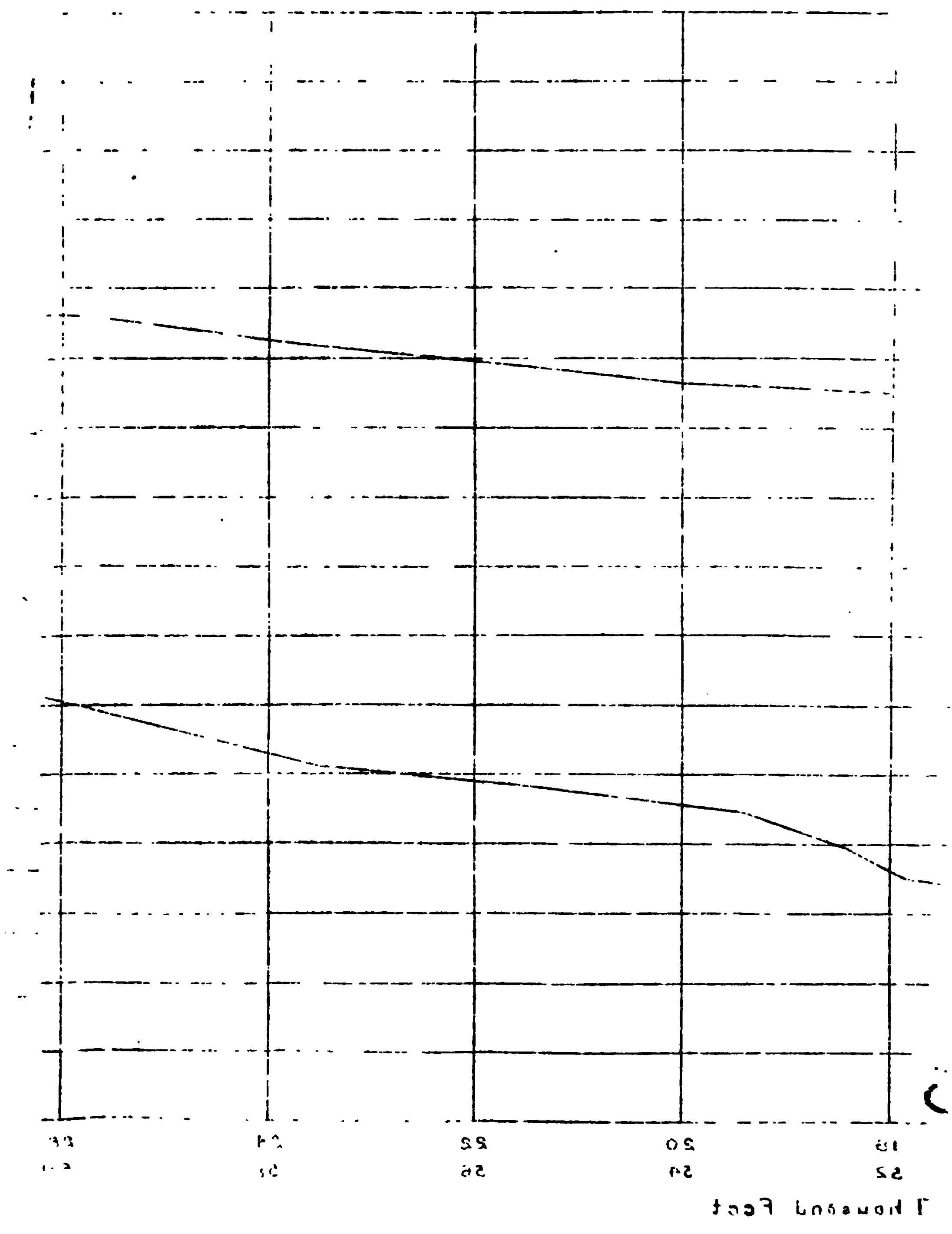
FIG. 5

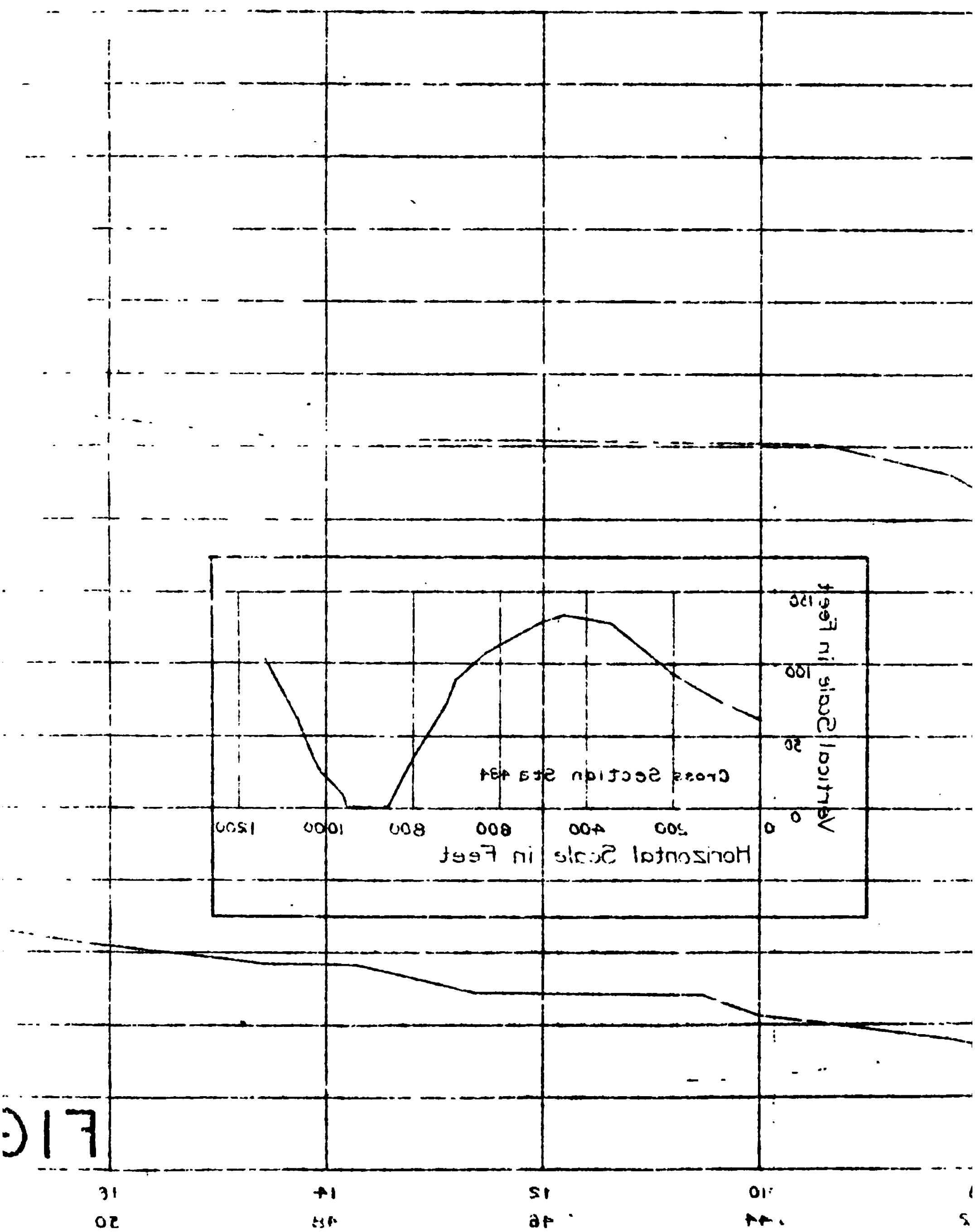

BM
SURVEY
NGINEER
ORK
20
15
10
5
BM





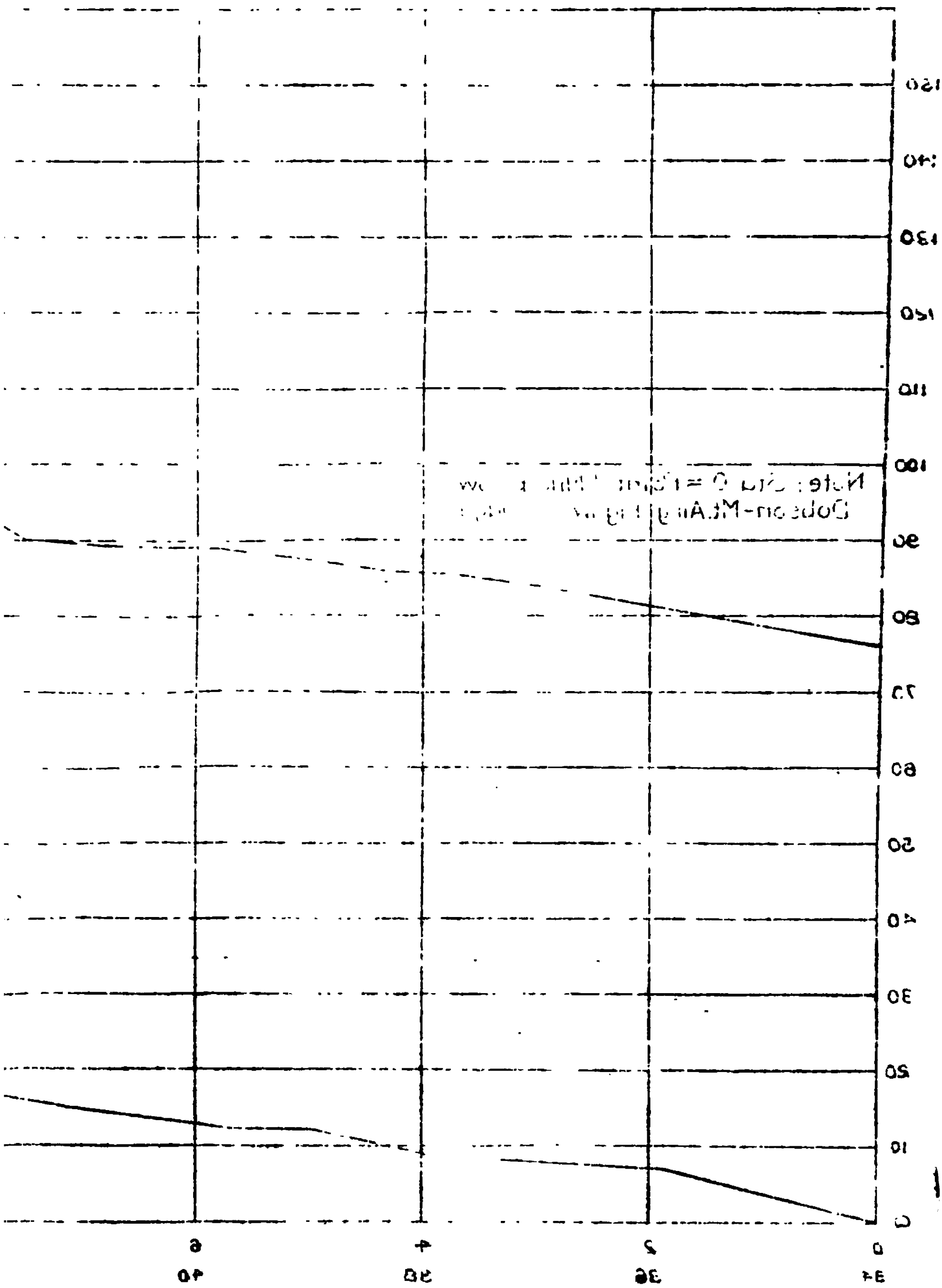
.6


18
20
22
52
54
56
Thousand Feet


Cross Section Sta 434
Horizontal Scale in Feet
0
200
400
600
800
1000
1200
Vertical Scale in Feet
0
50
100
150
16
14
12
10
50
48
46
44

FIG

Scal


150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
6
4
2
0
40
38
36
34

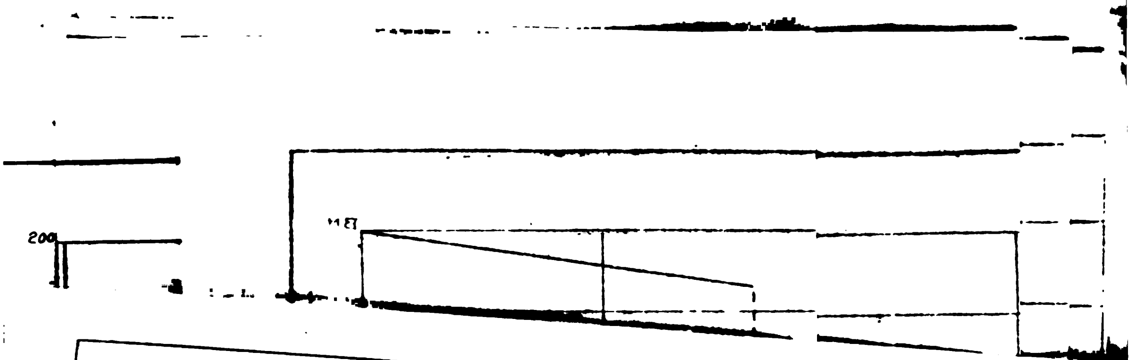
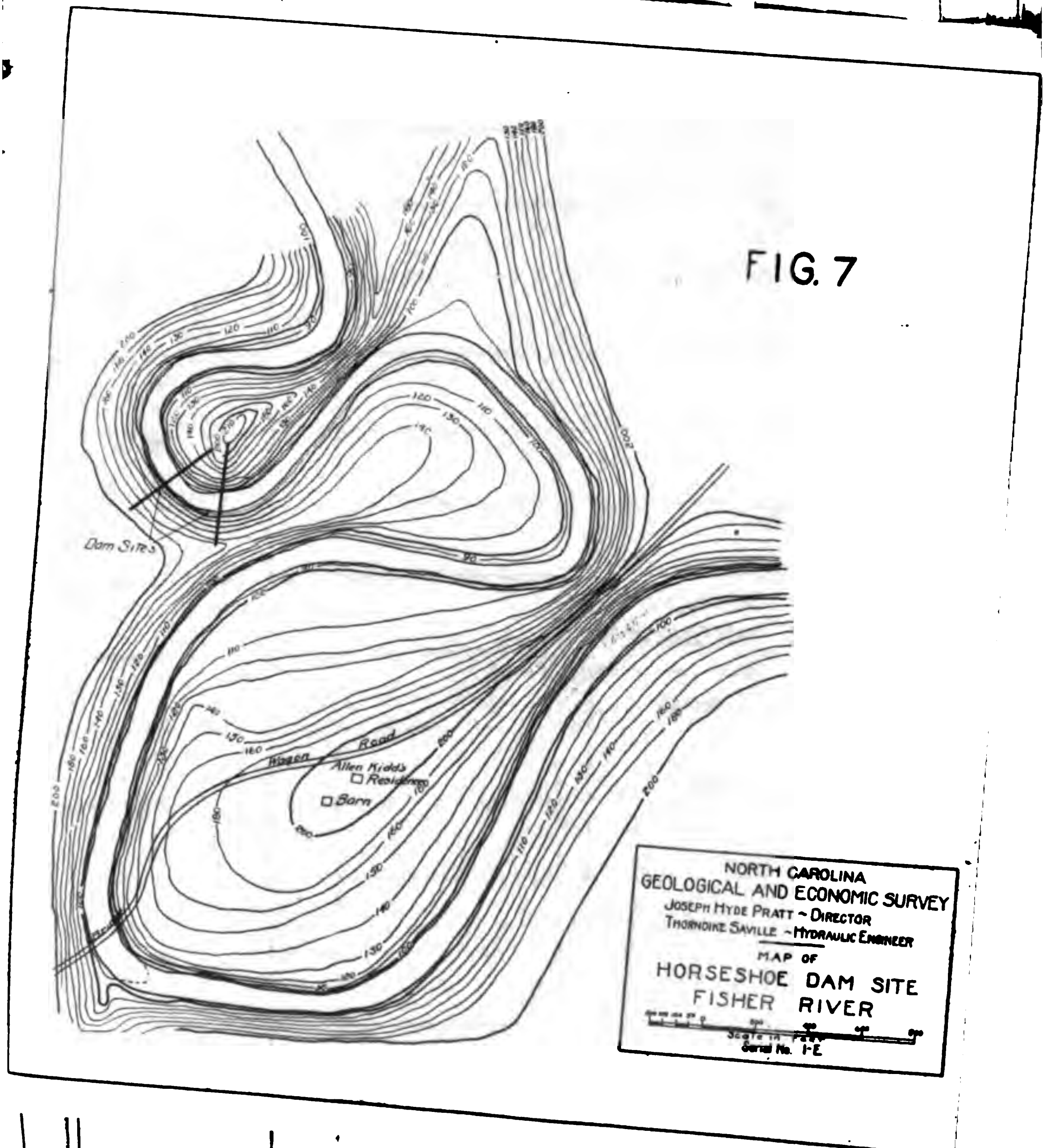

200

FIG. 7


Dam Sites
Wagon Road
Allen Kidd's Residence
Barn
NORTH CAROLINA
GEOLOGICAL AND ECONOMIC SURVEY
JOSEPH HYDE PRATT ~ DIRECTOR
THORNDIKE SAVILLE ~ HYDRAULIC ENGINEER
MAP OF
HORSESHOE DAM SITE
FISHER RIVER
Scale in Feet
Serial No. 1-E

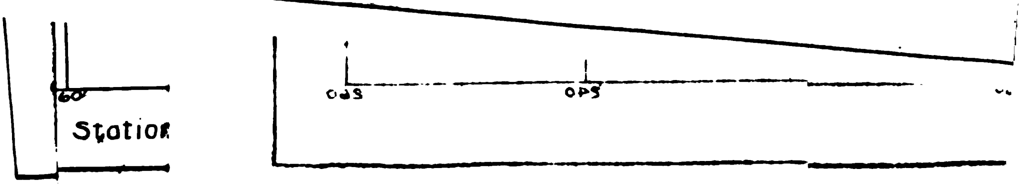
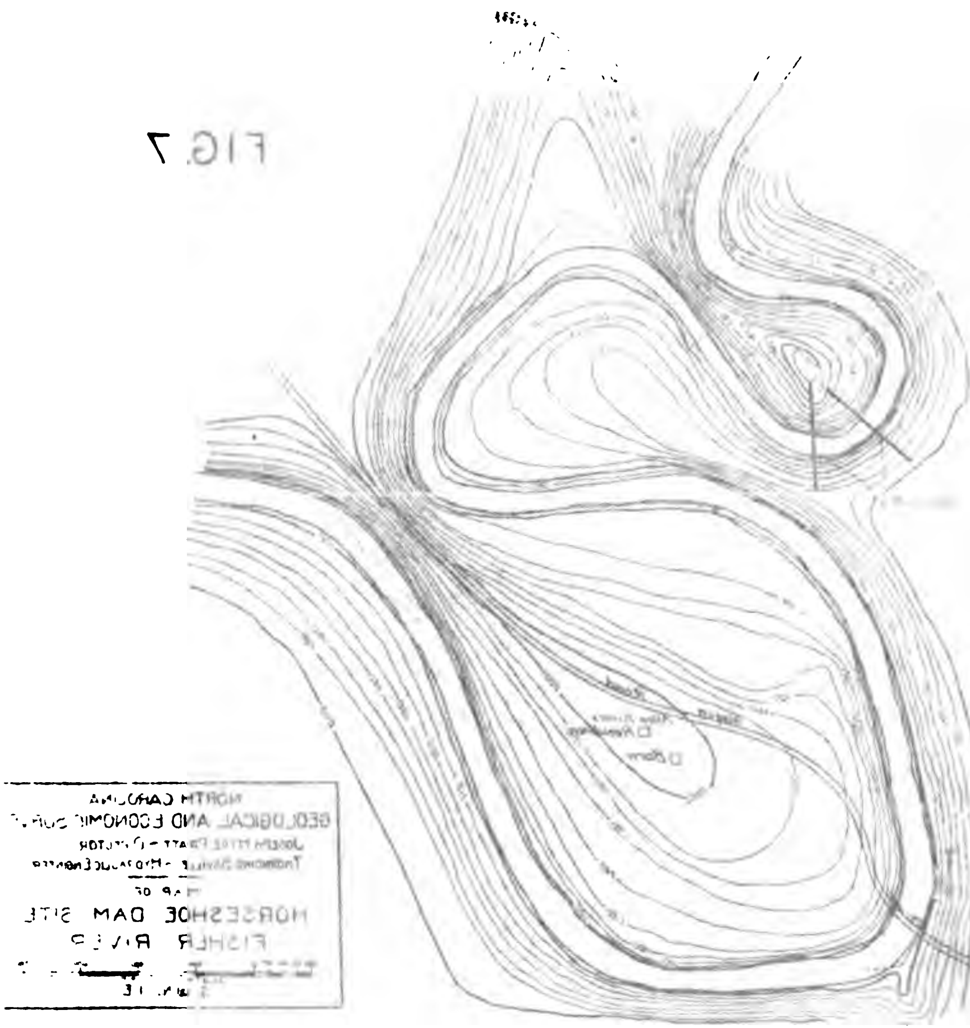
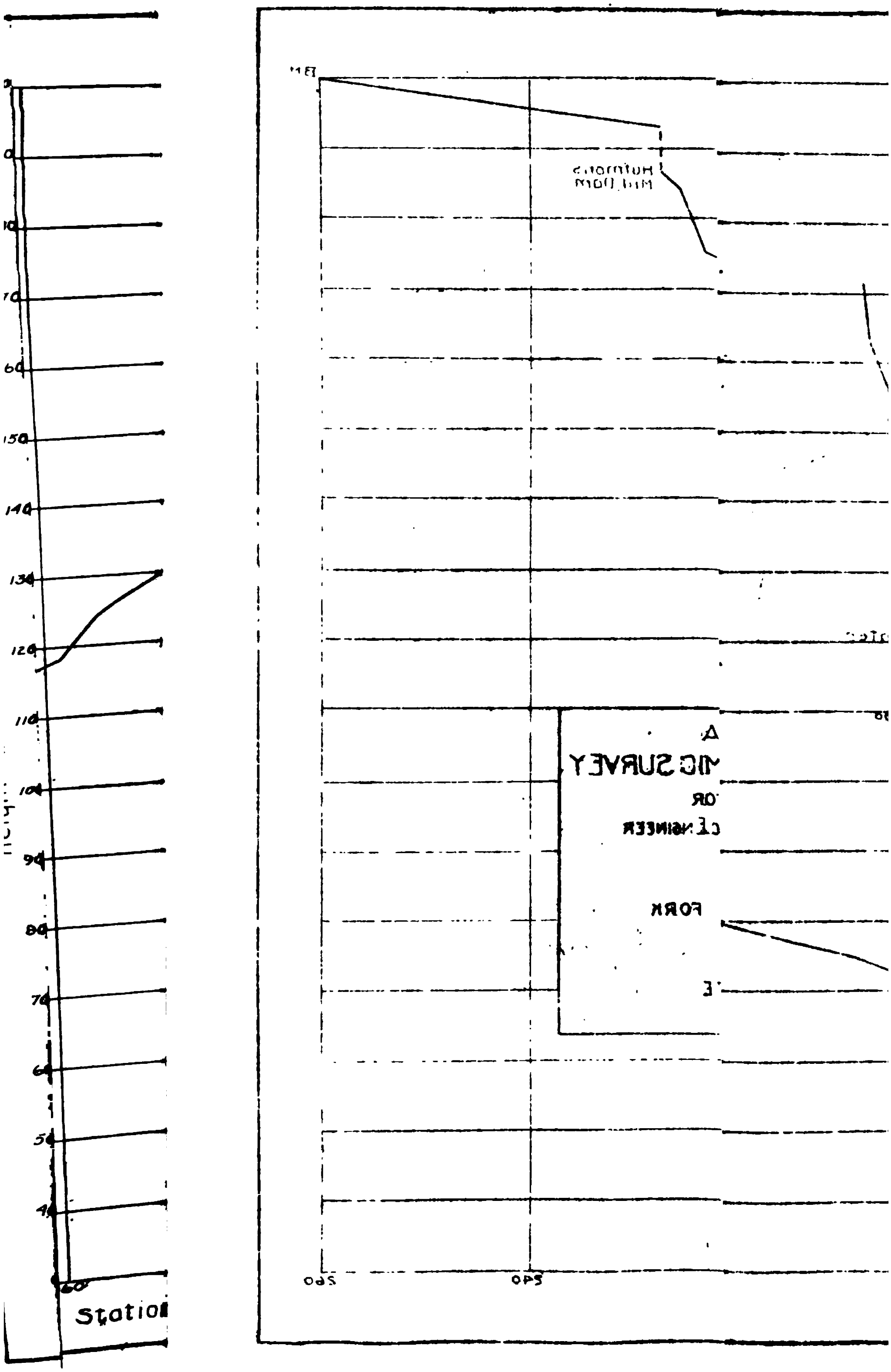
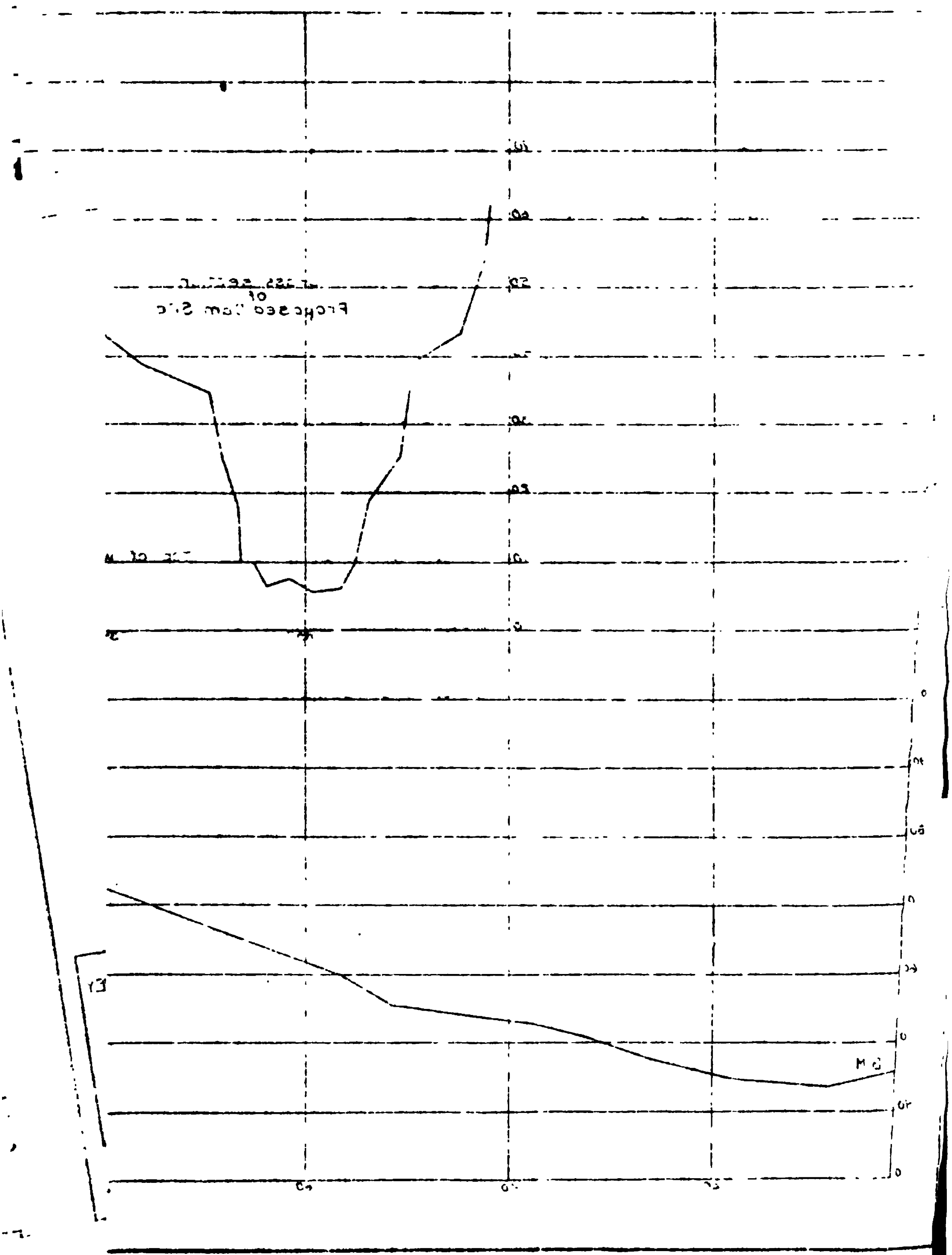
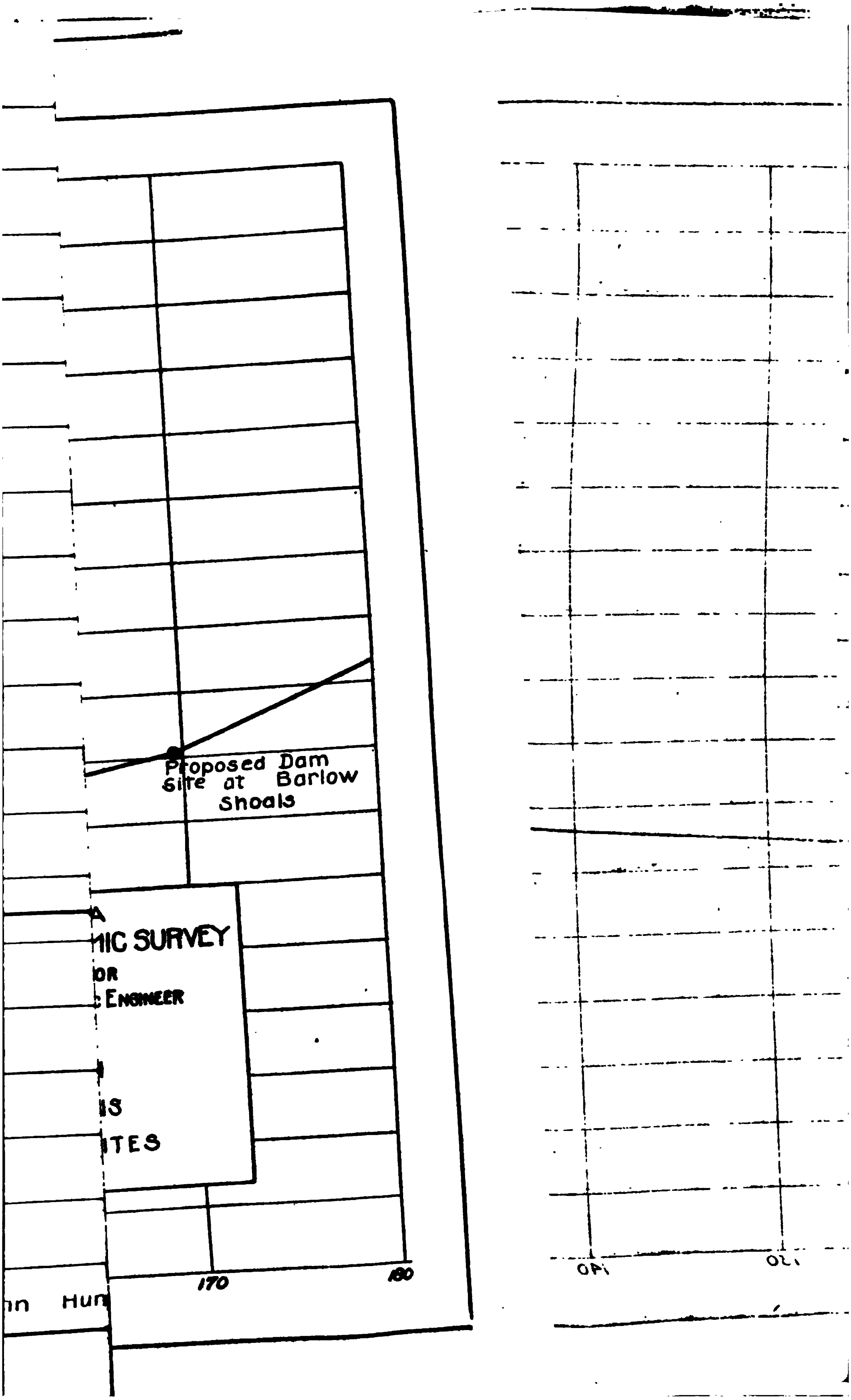

60'
Station

FIG. 7


NORTH CAROLINA
GEOLOGICAL AND ECONOMIC SURVEY
JOSEPH HYDE PRATT - DIRECTOR
THORNDIKE SAVILLE - HYDRAULIC ENGINEER
MAP OF
HORSESHOE DAM SITE
FISHER RIVER
SCALE
Road
Barn


150
140
130
120
110
90
80
70
Station




Proposed Dam Site at Barlow Shoals
170
180
MIC SURVEY
ENGINEER
ITES

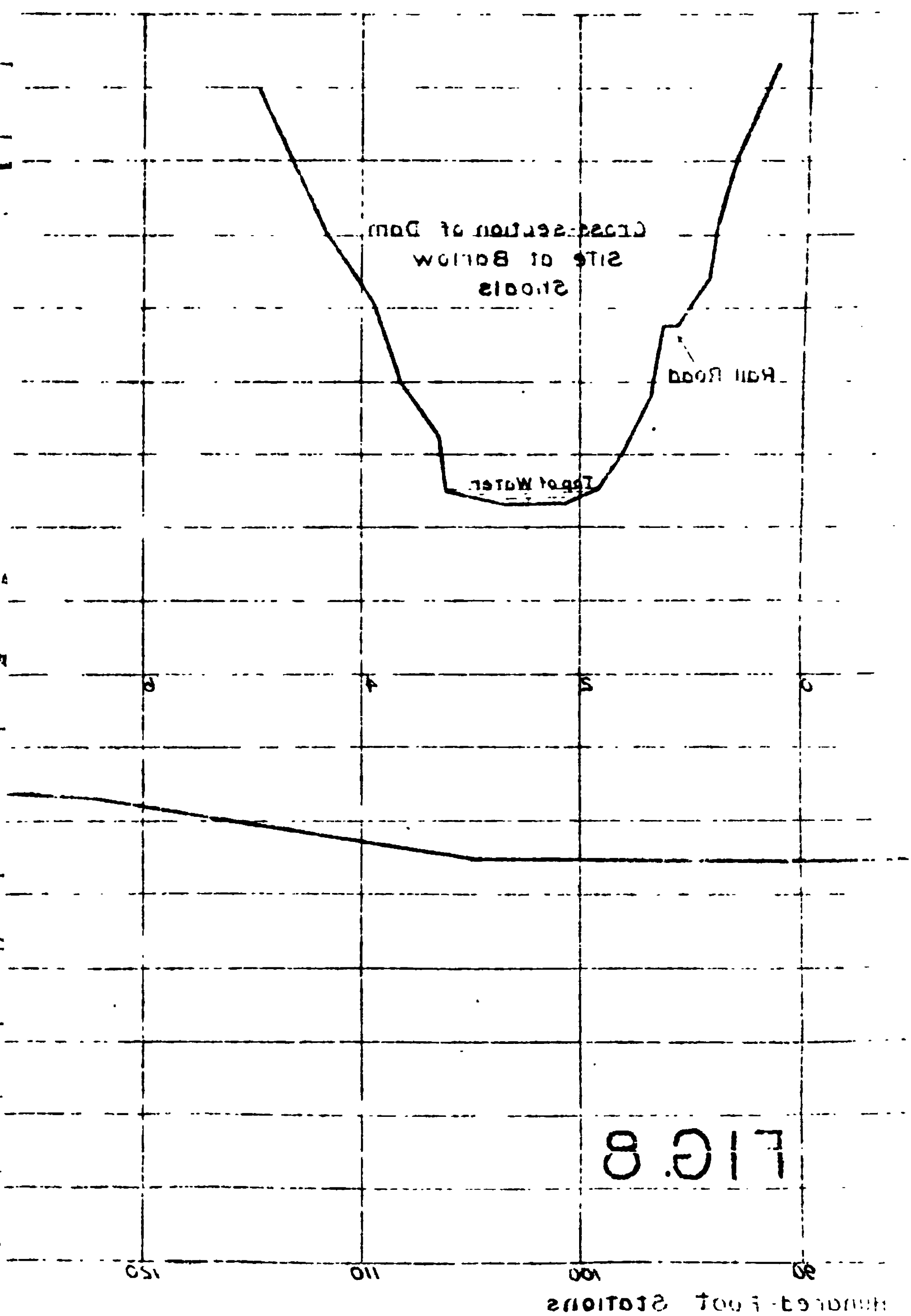
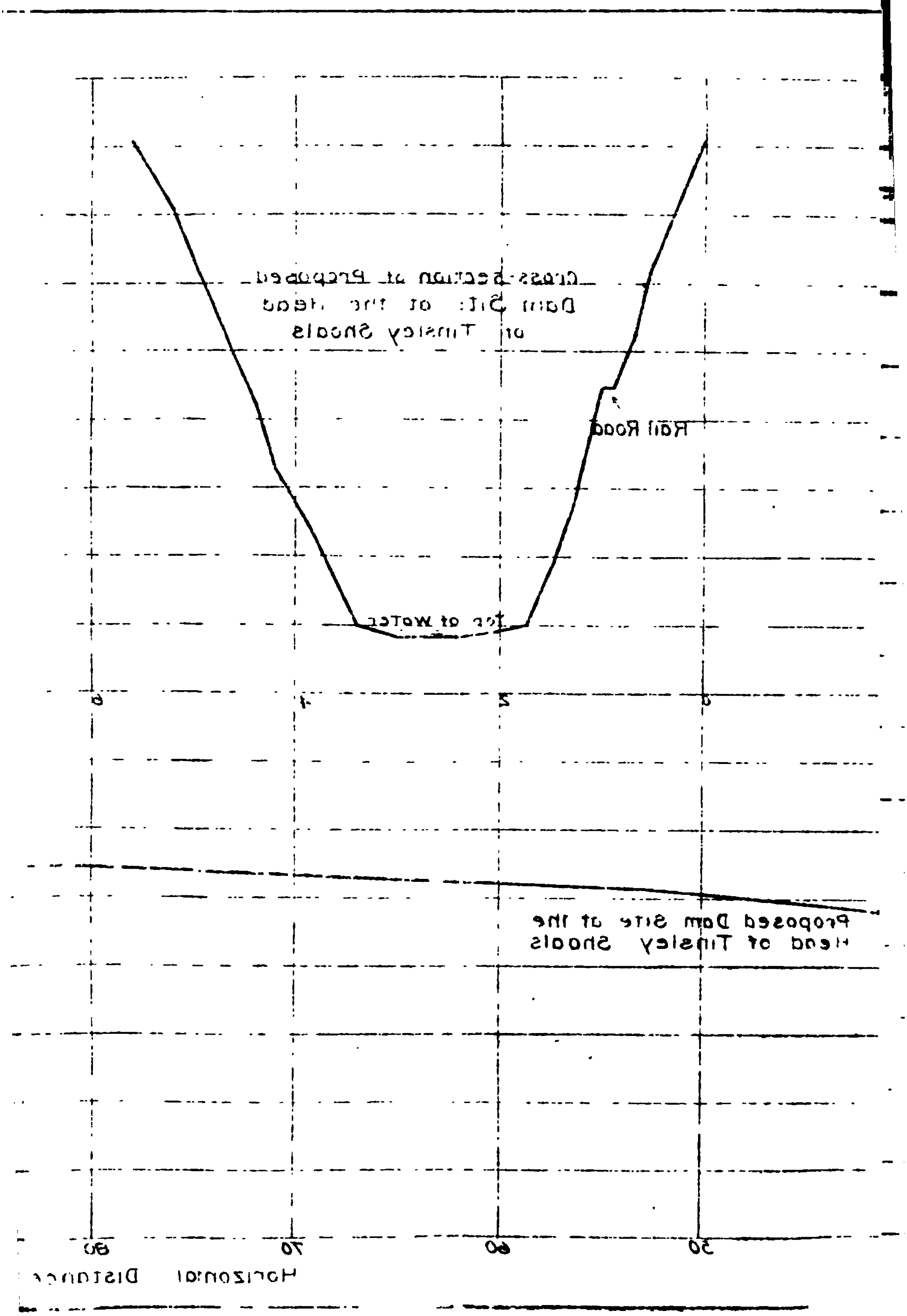
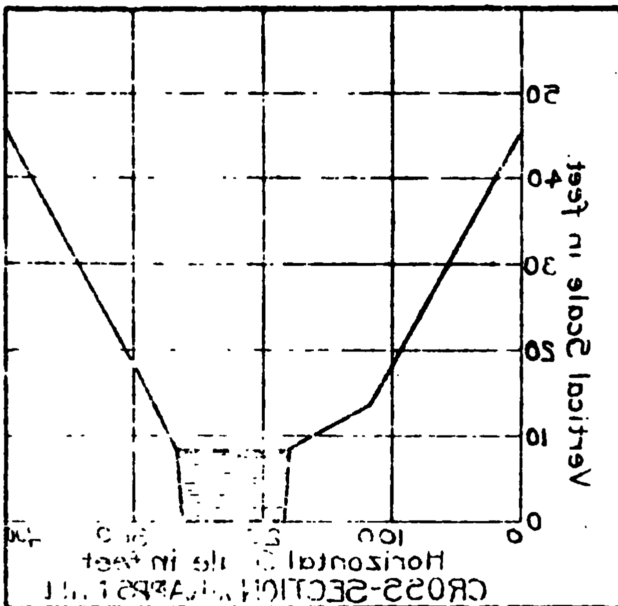

Cross-section of Dam
Site at Barrow
Shoals
Rail Road
Top of Water
6
4
2
0
120
110
100
90
Hundred-Foot Stations

FIG. 8

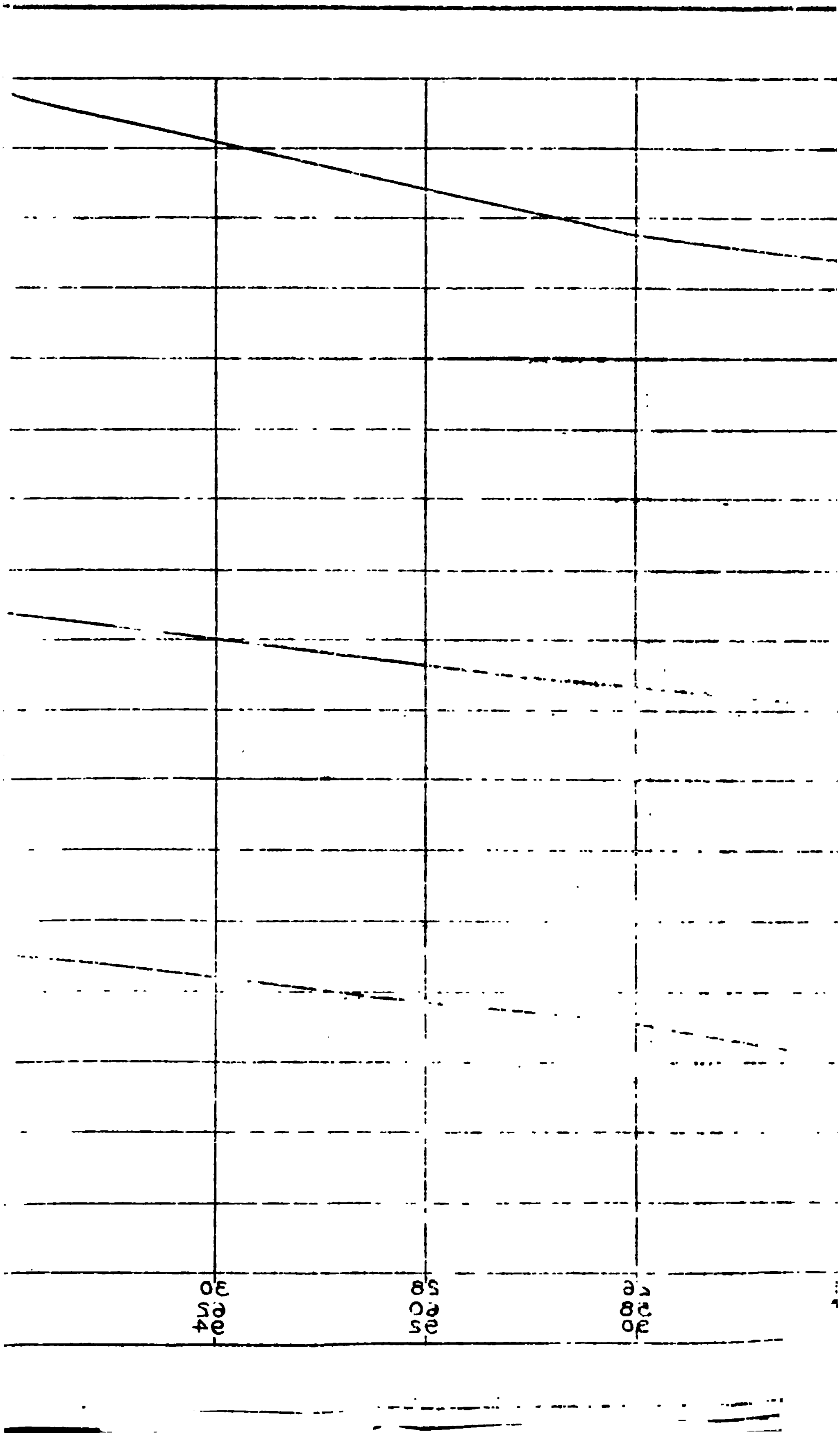

Cross-Section at Proposed
Dam Site at the Head
of Tinsley Shoals
Rail Road
of Water
6
4
2
0
Proposed Dam Site at the
Head of Tinsley Shoals
80
70
60
50
Horizontal Distance



NORTH CAROLINA
GEOLOGICAL AND ECONOMIC SURVEY
JOSEPH HYDE PRATT ~ DIRECTOR
THORNDIKE SAVILLE ~ HYDRAULIC ENGINEER

PROFILE OF MITCHELL RIVER
BEGINNING
ONE MILE BELOW CUMMING'S MILL

Serial No. ~ L-1


30
62
94
28
60
92
26
58
90

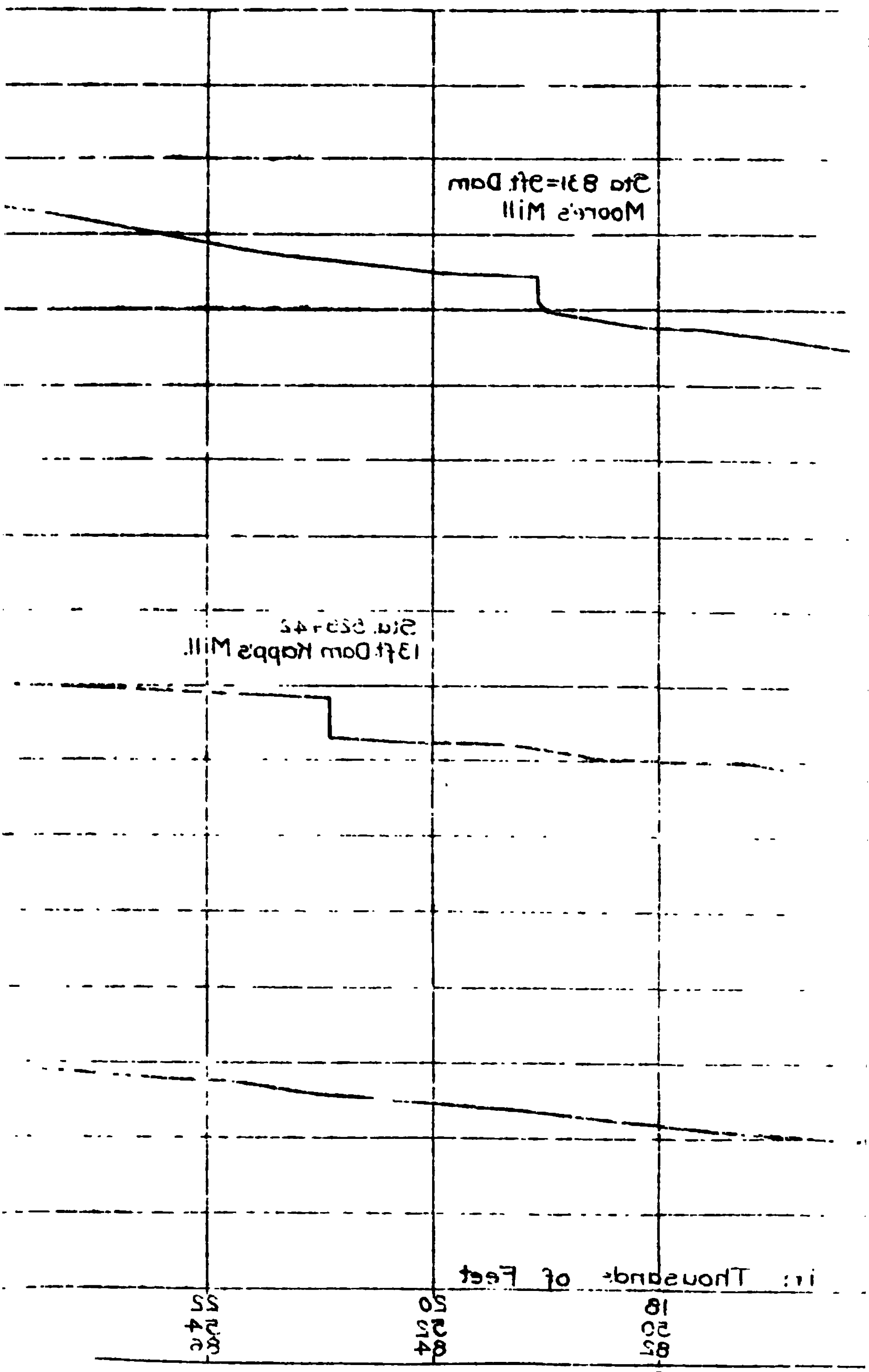
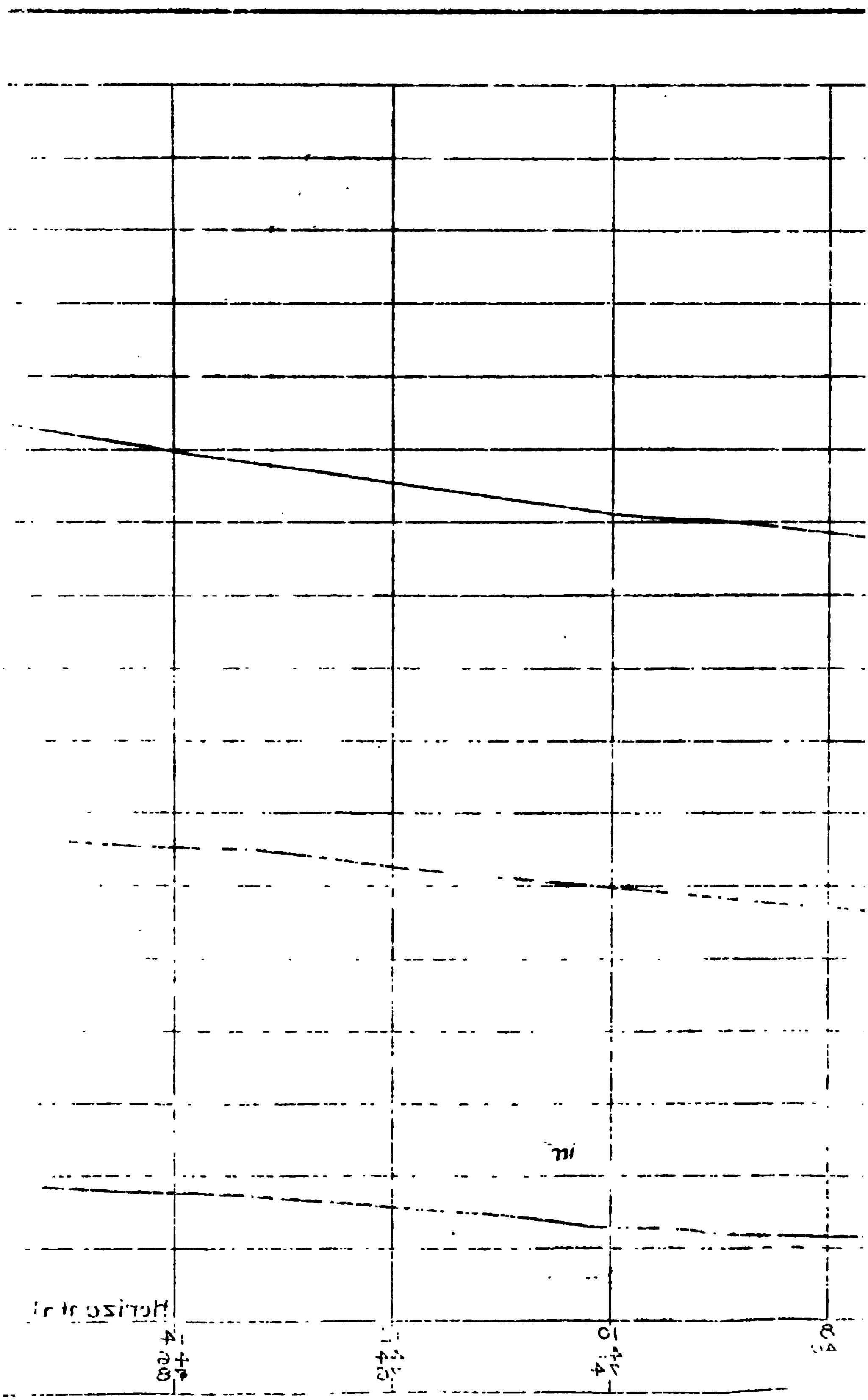
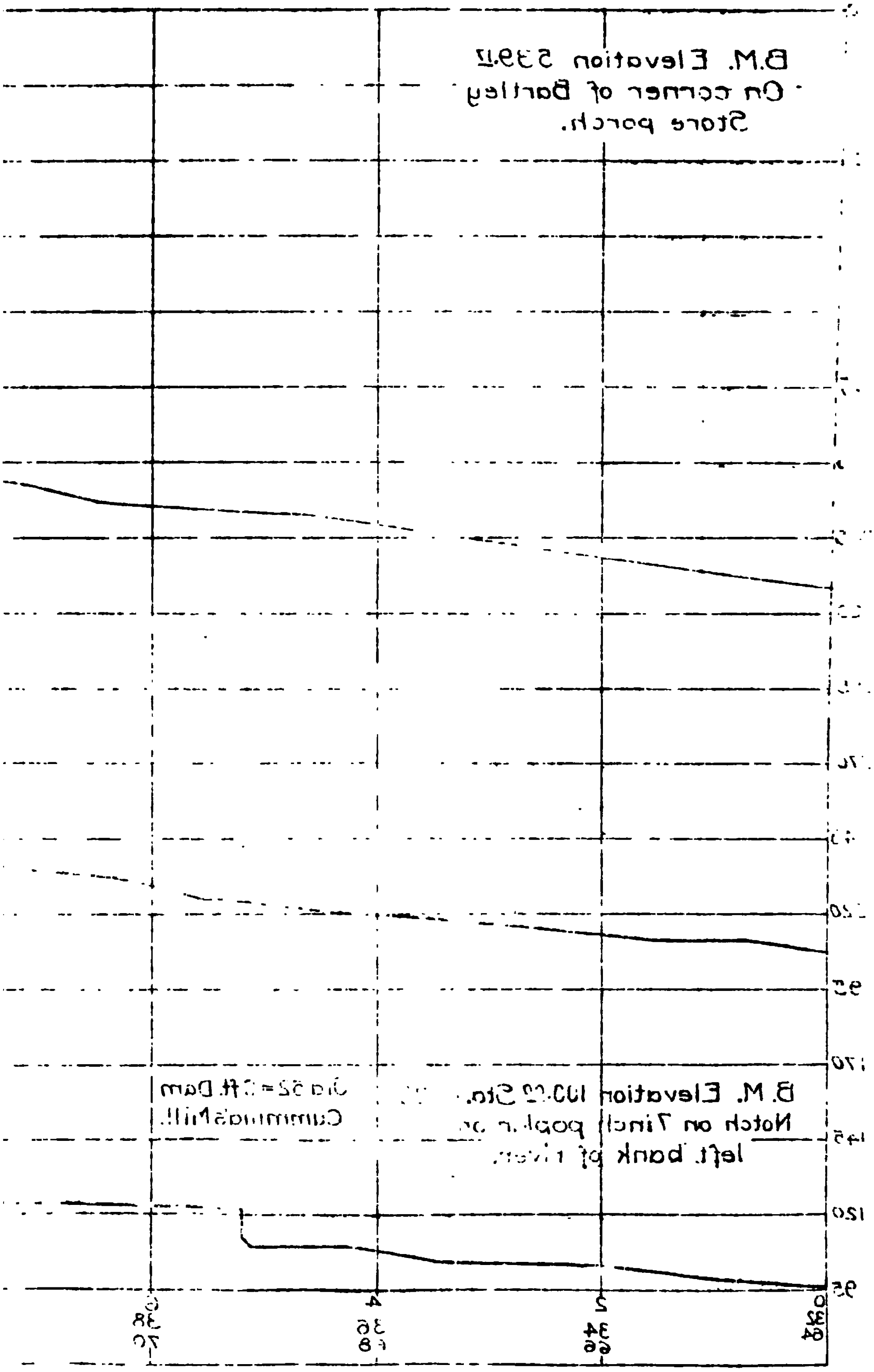
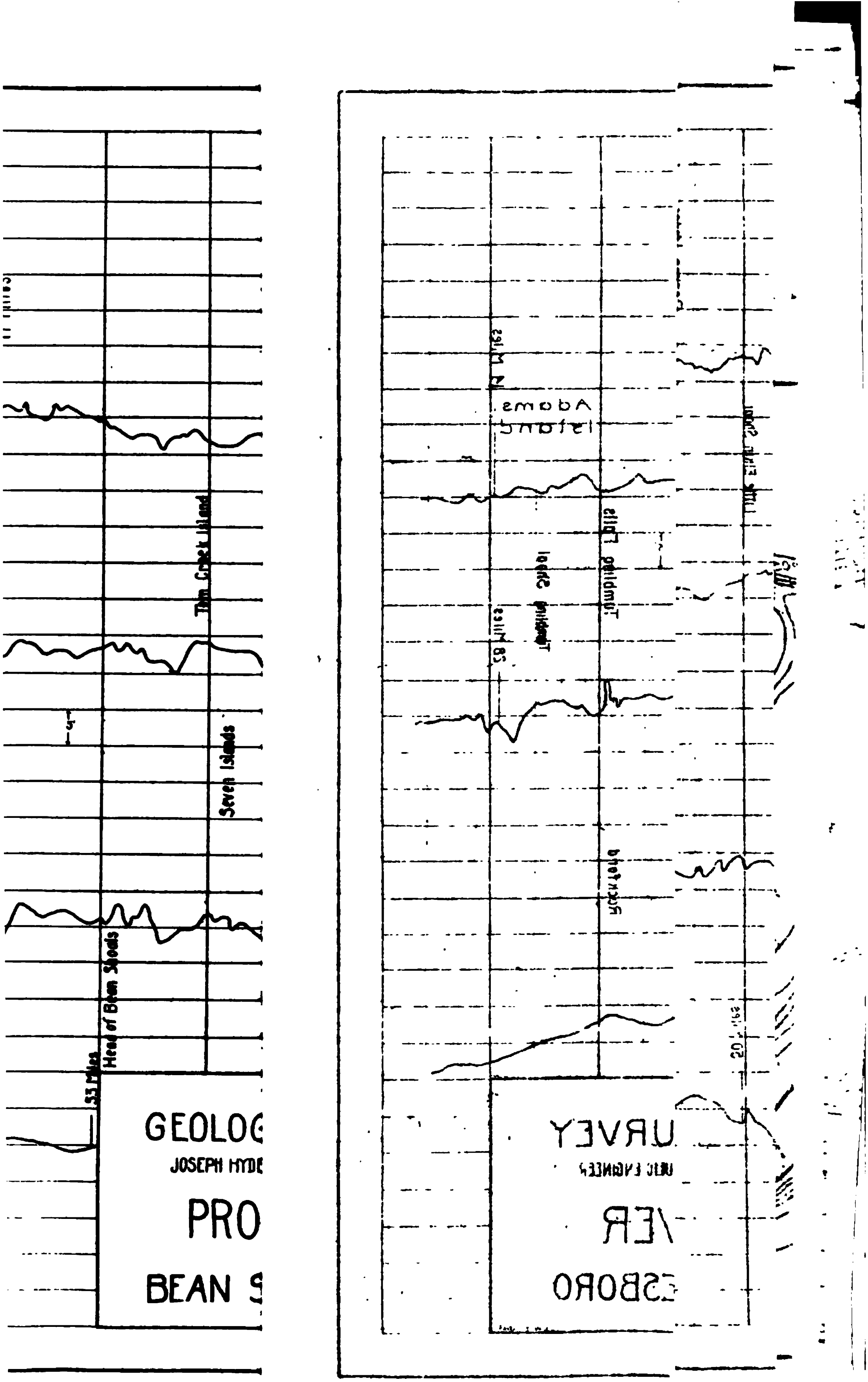

Sta 831=9ft Dam
Moore's Mill
Sta. 523+42
13ft Dam Kapp's Mill
in Thousands of Feet
22
54
86
20
52
84
18
50
82

FIG 8





B.M. Elevation 539.12
On corner of Bartley
Store porch.
B. M. Elevation
Notch on
left bank
Cummins Mill


Thin Creek Island
Seven Islands
Head of Bean Shoals
53 Miles
GEOLOG
JOSEPH HYDE
PRO
BEAN S

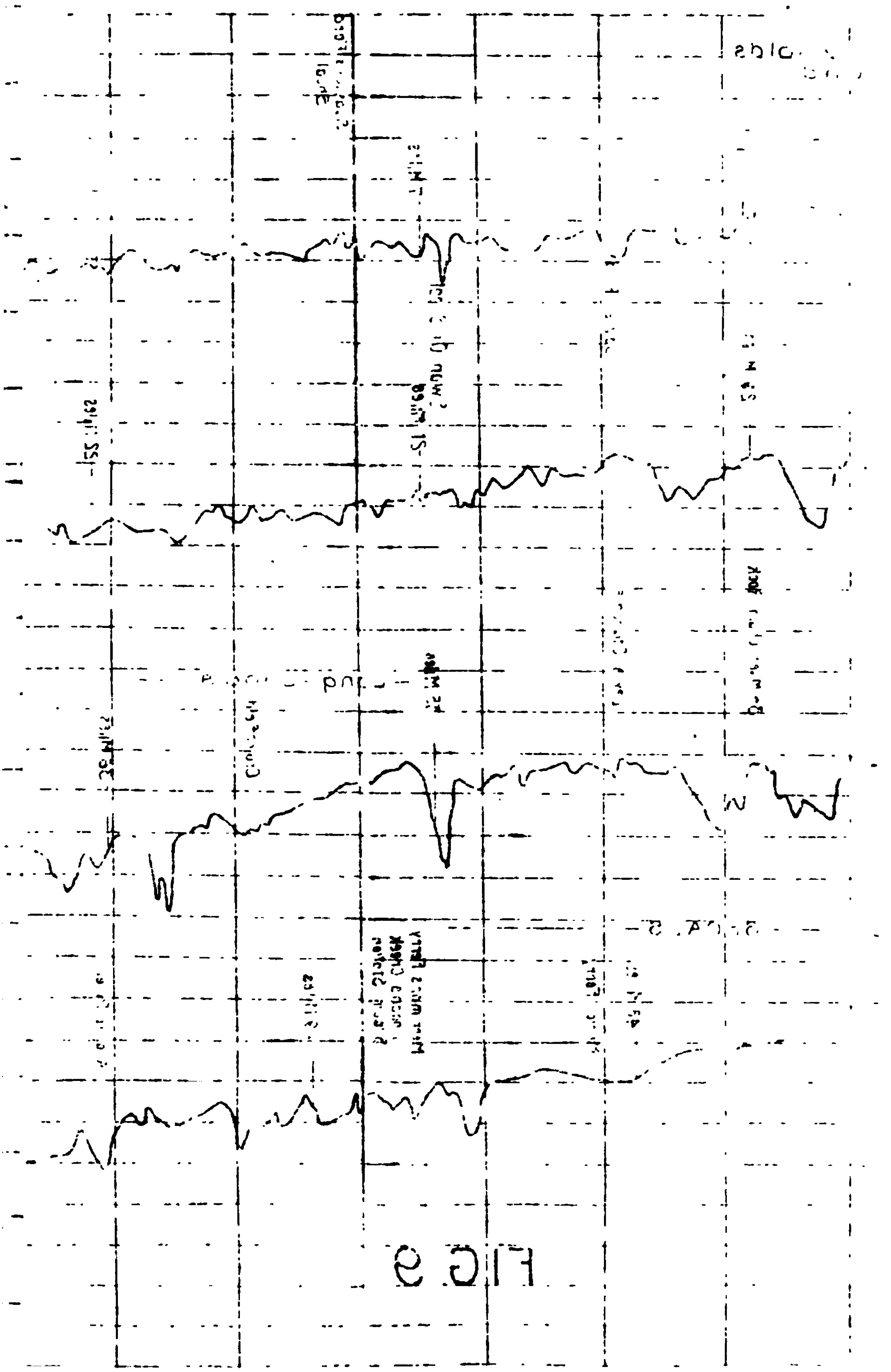
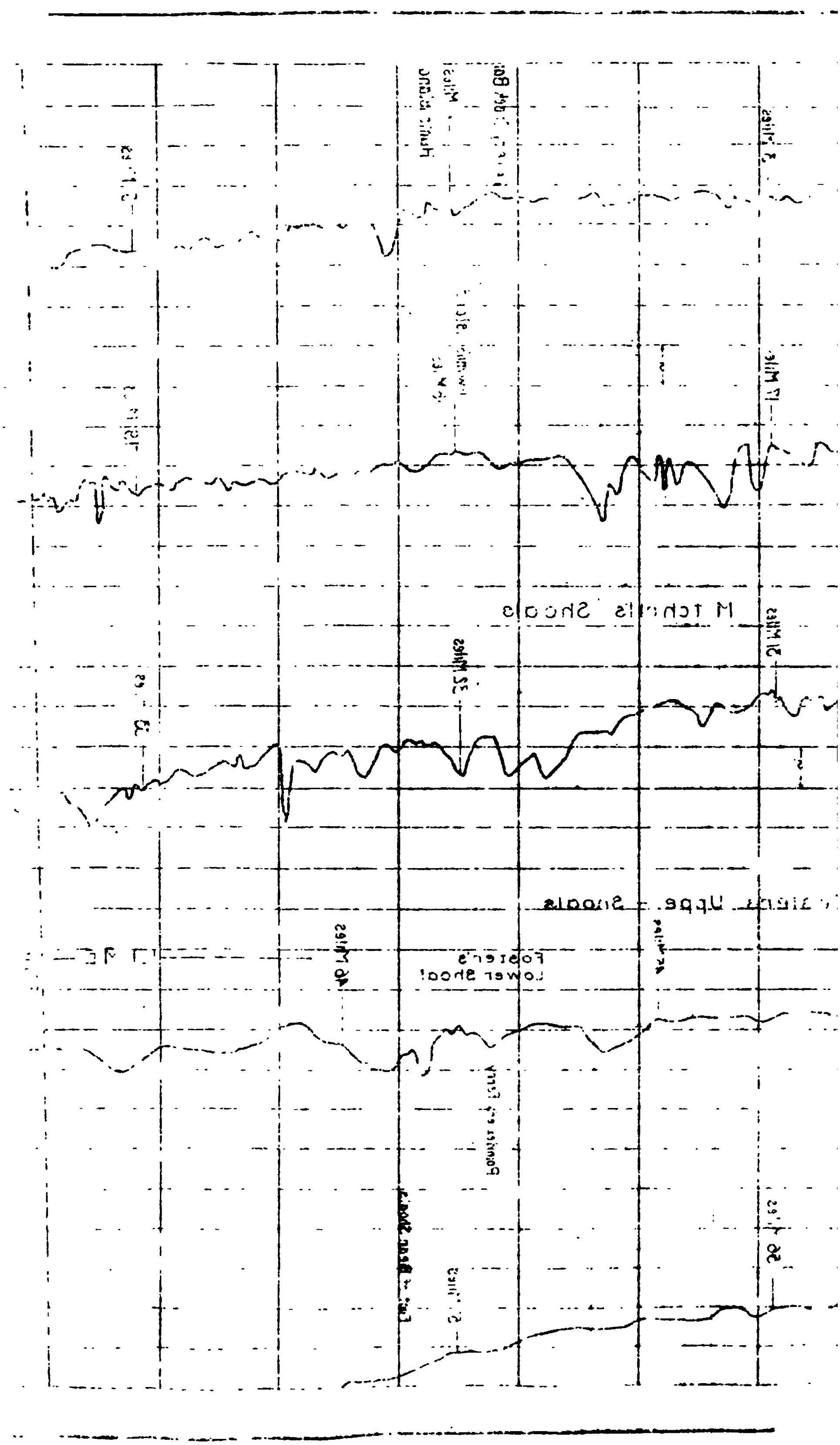
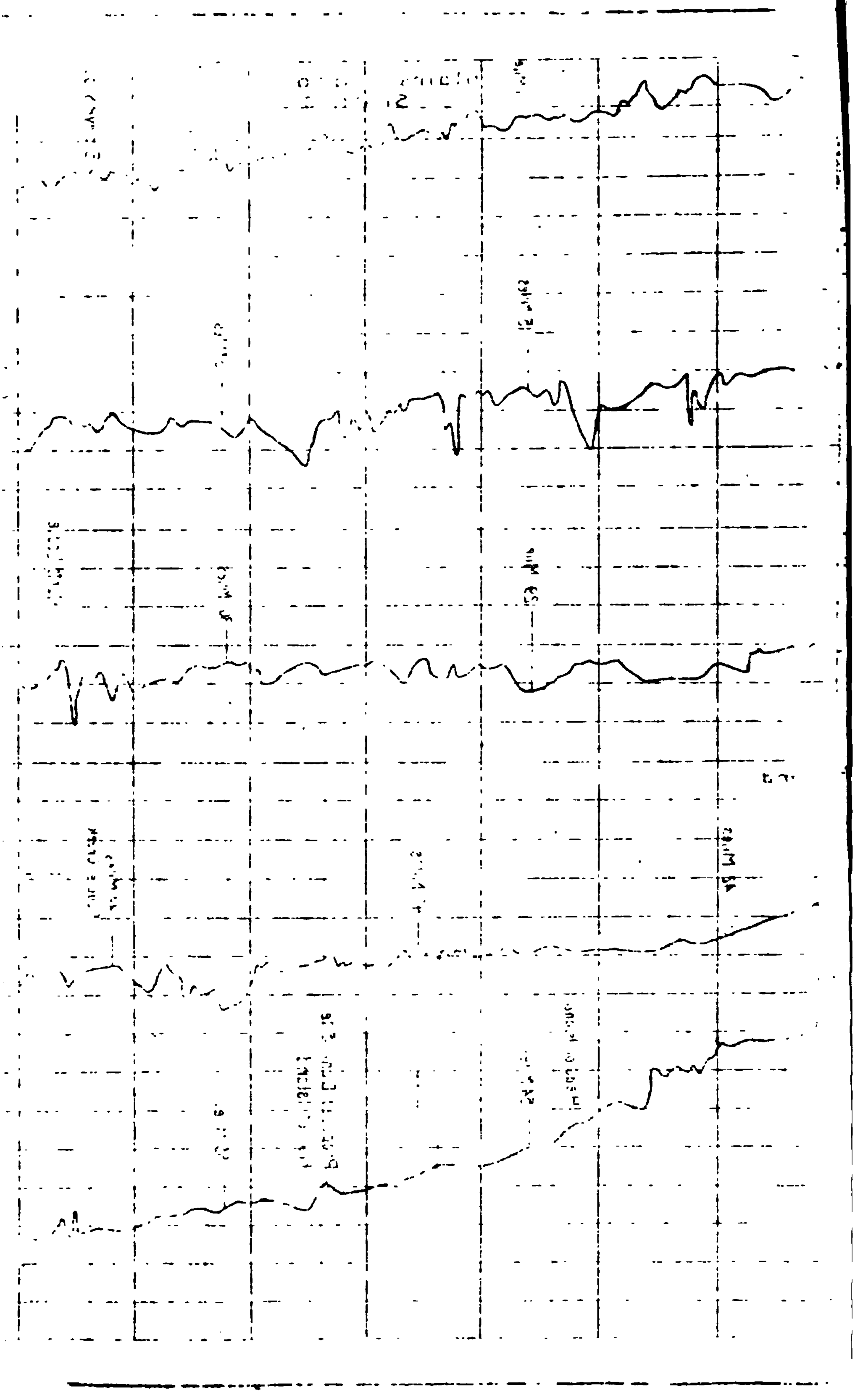


FIG 9


Mitchells Shoals
Foster's
Lower Shoal
21 Miles
27 Miles
46 Miles
17 Miles



The Randleman rainfall records may, however, be safely applied to the drainage area tributary to the gaging station at Ramseur.

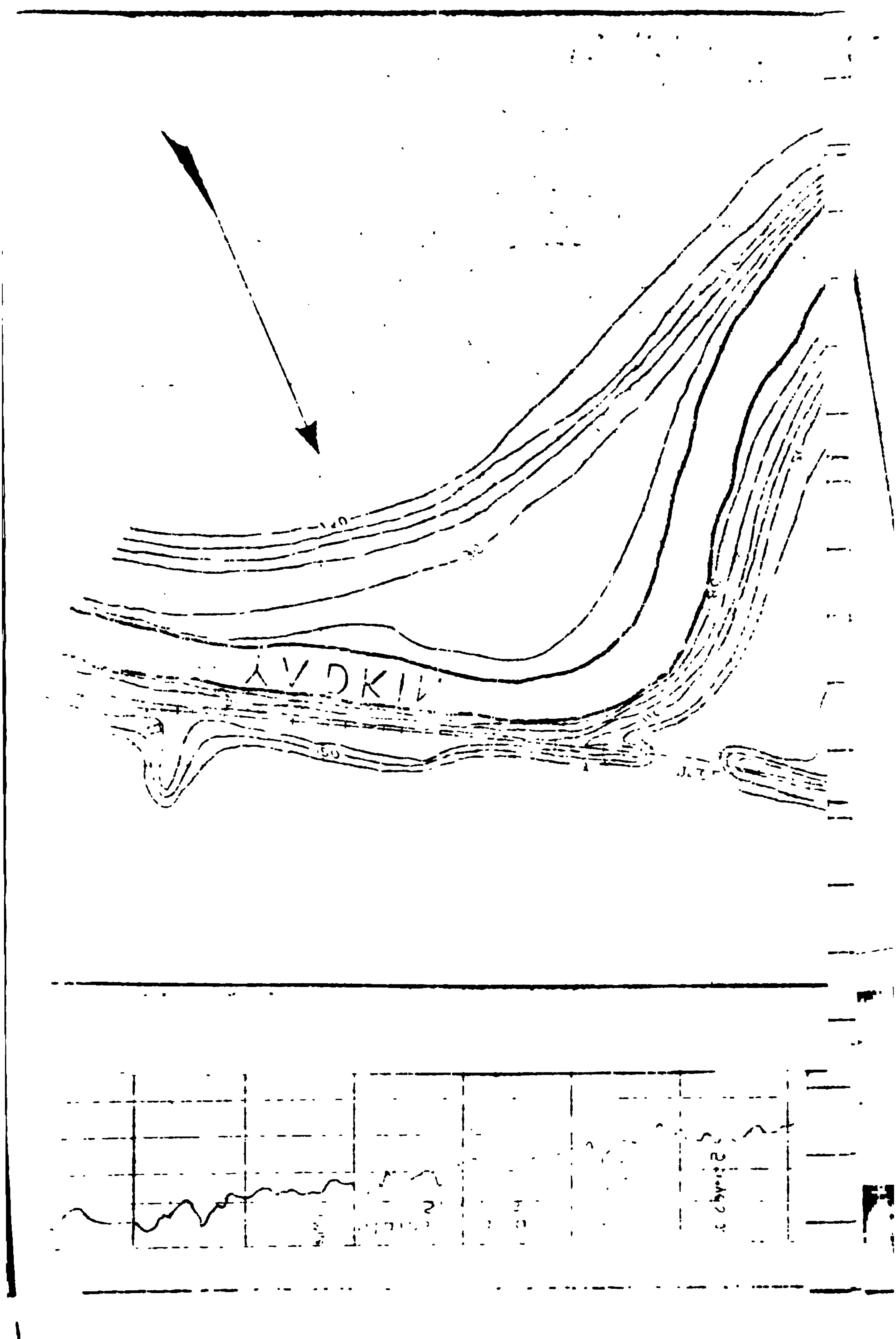
The monthly and annual rainfall at Randleman are given in Table 3. It will be seen that the minimum annual rainfall of 36.59 inches occurred in 1911, whereas the year of least rainfall for the general Piedmont region was 1921. The minimum monthly rainfall of 0.24 inches occurred in September, 1919, and there have been several years in which monthly rainfalls were less than those recorded in 1911 or

TABLE 3.—MONTHLY AND ANNUAL RAINFALL AT RANDLEMAN, N. C.

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total for Year
1905	3.00	5.42	1.93	3.37	11.40	1.16	7.89	7.21	1.05	1.18	.49	8.18	52.28
1906	4.82	1.97	5.49	1.27	2.37	9.20	9.64	12.53	2.09	2.91	.82	3.33	56.44
1907	.61	3.53	2.70	4.19	2.57	5.14	2.84	3.14	5.58	.71	5.09	5.08	41.18
1908	5.14	4.44	4.17	3.12	2.42	4.59	4.13	9.34	3.64	3.23	2.09	4.60	50.91
1909	1.49	3.62	3.04	1.44	6.95	7.35	4.54	7.30	1.80	2.58	.52	2.35	42.98
1910	3.77	2.87	2.51	2.44	2.81	6.21	5.89	2.81	2.03	4.90	.87	3.38	40.49
1911	2.85	2.21	3.53	3.40	2.74	2.03	1.05	5.15	2.05	4.15	3.34	4.09	36.59
1912	3.02	3.68	7.10	3.19	2.67	6.46	2.82	1.58	3.35	1.41	2.30	2.38	39.96
1913	4.71	3.62	7.69	2.55	5.44	3.77	5.47	4.51	5.33	2.20	3.75	4.64	53.68
1914	2.70	6.10	2.89	4.45	1.85	3.65	4.20	5.00	2.15	4.30	2.50	8.22	48.01
1915	5.51	3.88	2.72	1.70	6.54	4.28	4.03	10.39	3.44	4.76	1.90	3.05	52.20
1916	1.88	5.90	2.11	3.08	4.45	7.60	6.95	5.30	1.15	2.20	1.30	3.27	45.19
1917	4.70	3.97	8.71	3.05	2.90	4.45	10.32	4.39	4.21	1.93	1.20	2.30	52.13
1918	6.07	1.26	2.22	6.31	4.12	1.82	10.31	2.88	6.07	1.15	2.60	3.98	48.79
1919	5.32	3.81	2.92	2.50	6.07	2.76	9.97	3.13	.24	4.11	.52	2.03	43.38
1920	4.28	3.68	5.09	5.93	1.68	3.56	5.15	5.60	3.51	.74	4.13	6.65	50.00
1921	5.83	5.06	2.48	3.41	3.85	3.12	3.76	1.53	2.57	1.20	3.95	2.81	38.94
1922	3.86	5.84	7.32	3.31	5.93	5.15	7.54	3.24	.97	3.94	.37	3.77	51.24
1923	4.04	3.55	8.38	5.14	3.92	1.97	7.68	2.74	3.08	1.31	2.76	2.50	47.07
Average	3.87	3.92	4.36	3.36	4.25	4.44	6.01	5.14	2.86	2.57	2.13	4.03	46.93

1921. It will be noted, also, that the rainfall in the autumn months of 1923 was about as low as in the similar months of the low year, 1921. It follows from these and other considerations that extraordinary low stream flow may occur in years when the annual rainfall is considerably greater than in the minimum year. The stream flow in the fall of 1923 probably represents very nearly the minimum conditions likely to occur. The relation between monthly rainfall and run-off are shown by Table 4 and Plate VI. It is evident that no rainfall run-off formula can give the variations which actually occurred.

That rainfall, and consequently stream flow, occurs in more or less periodic high and low amounts is shown by the curve of progressive mean annual rainfall on Plate VII. It is evident from this curve that the years 1919 to 1923 have formed part of a dry period, and that the rainfall, and consequently the stream flow and water power, will probably be, on the average, greater during the next few years.

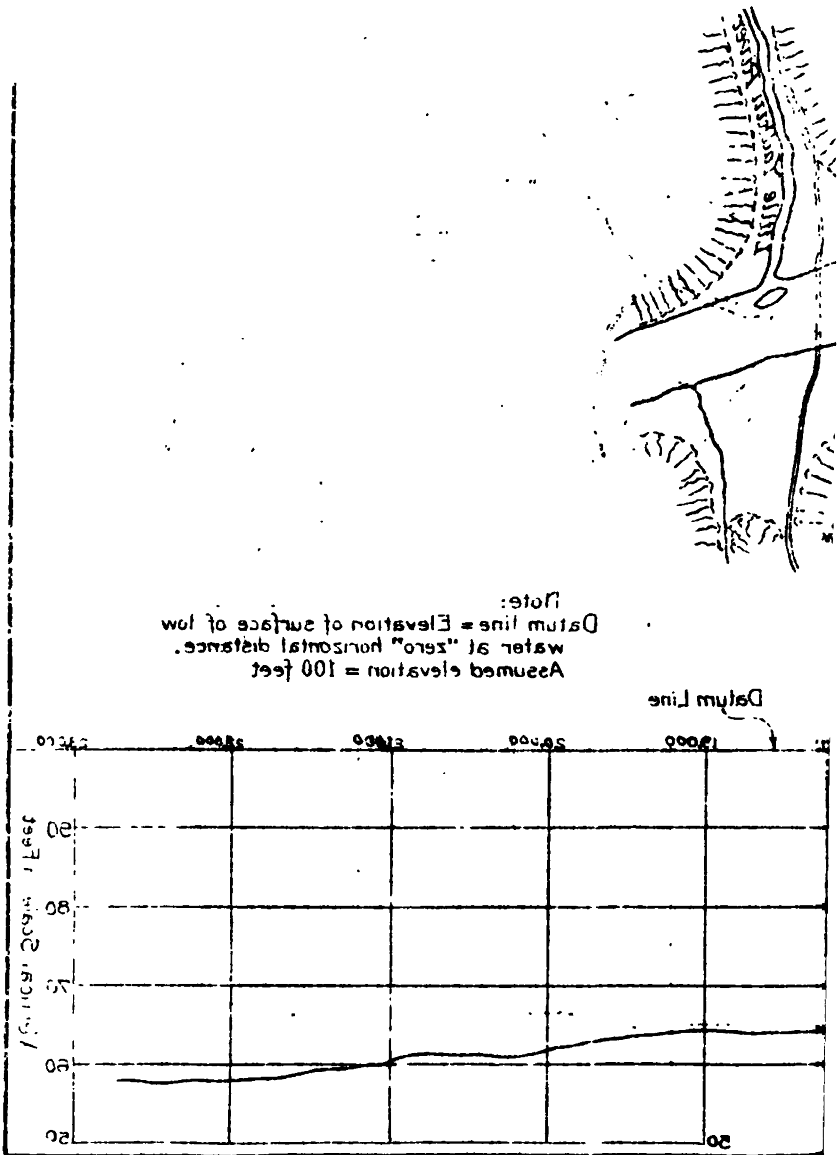


GEOL
Jo
Tri

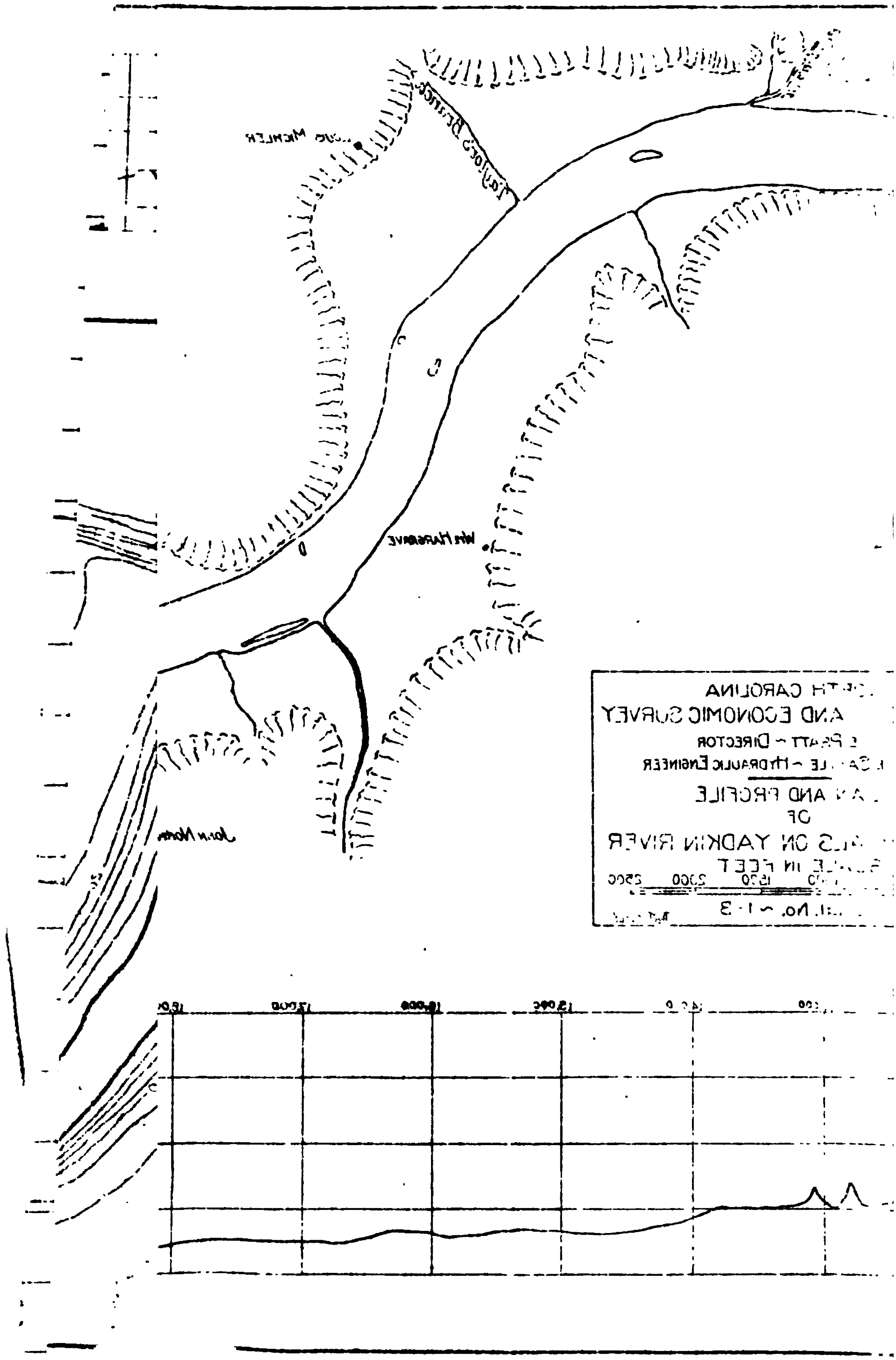
BEA

0

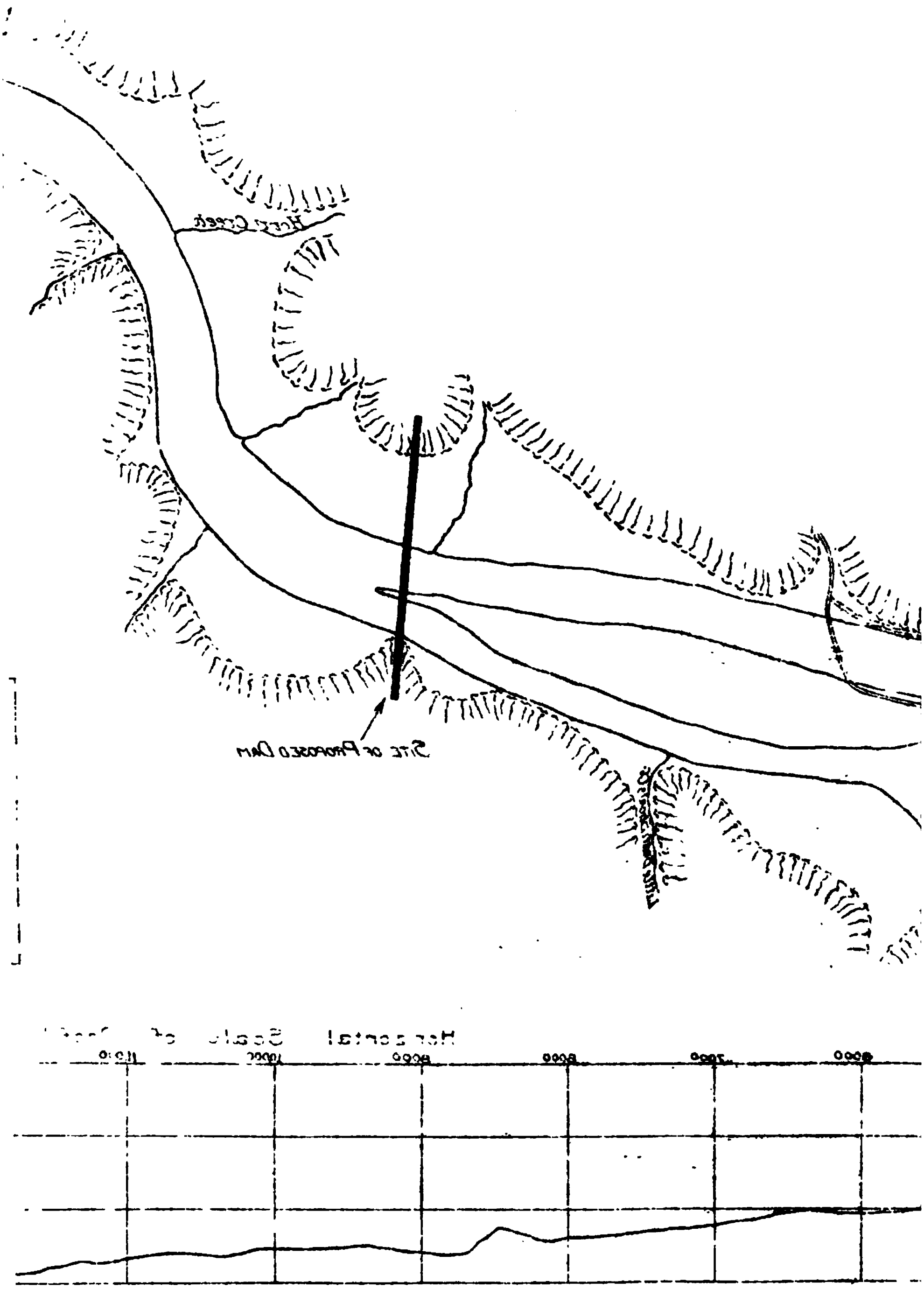
in
12,000



Note:
Datum line = Elevation of surface of low water at "zero" horizontal distance.
Assumed elevation = 100 feet

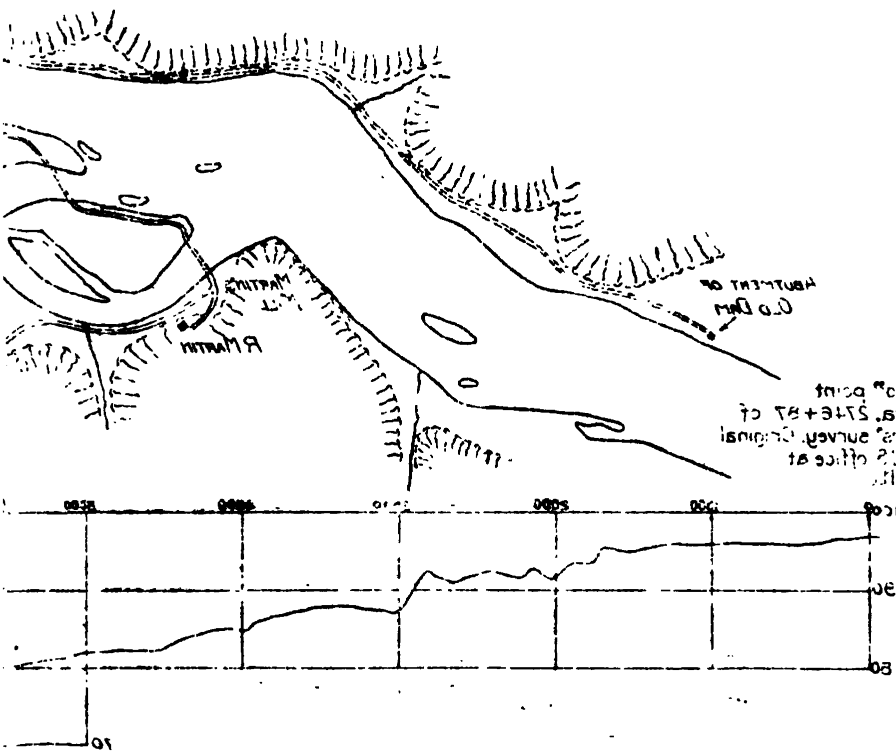


Taylors Branch
Wm Hargrave
CAROLINA
AND ECONOMIC SURVEY
PRATT – DIRECTOR
HYDRAULIC ENGINEER
AND PROFILE
OF
ON YADKIN RIVER
IN FEET
2500 2000 1500
No. 1-3

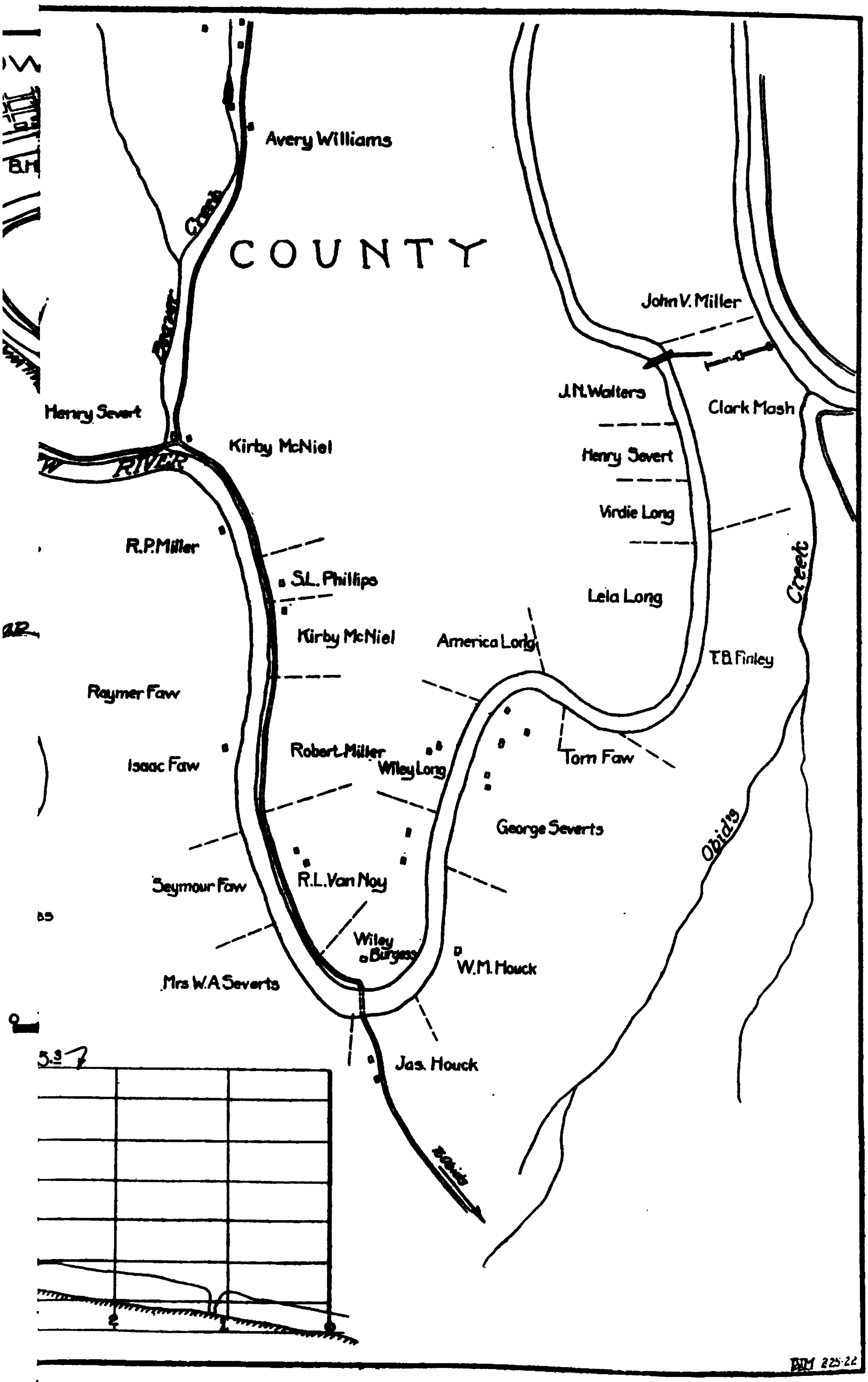


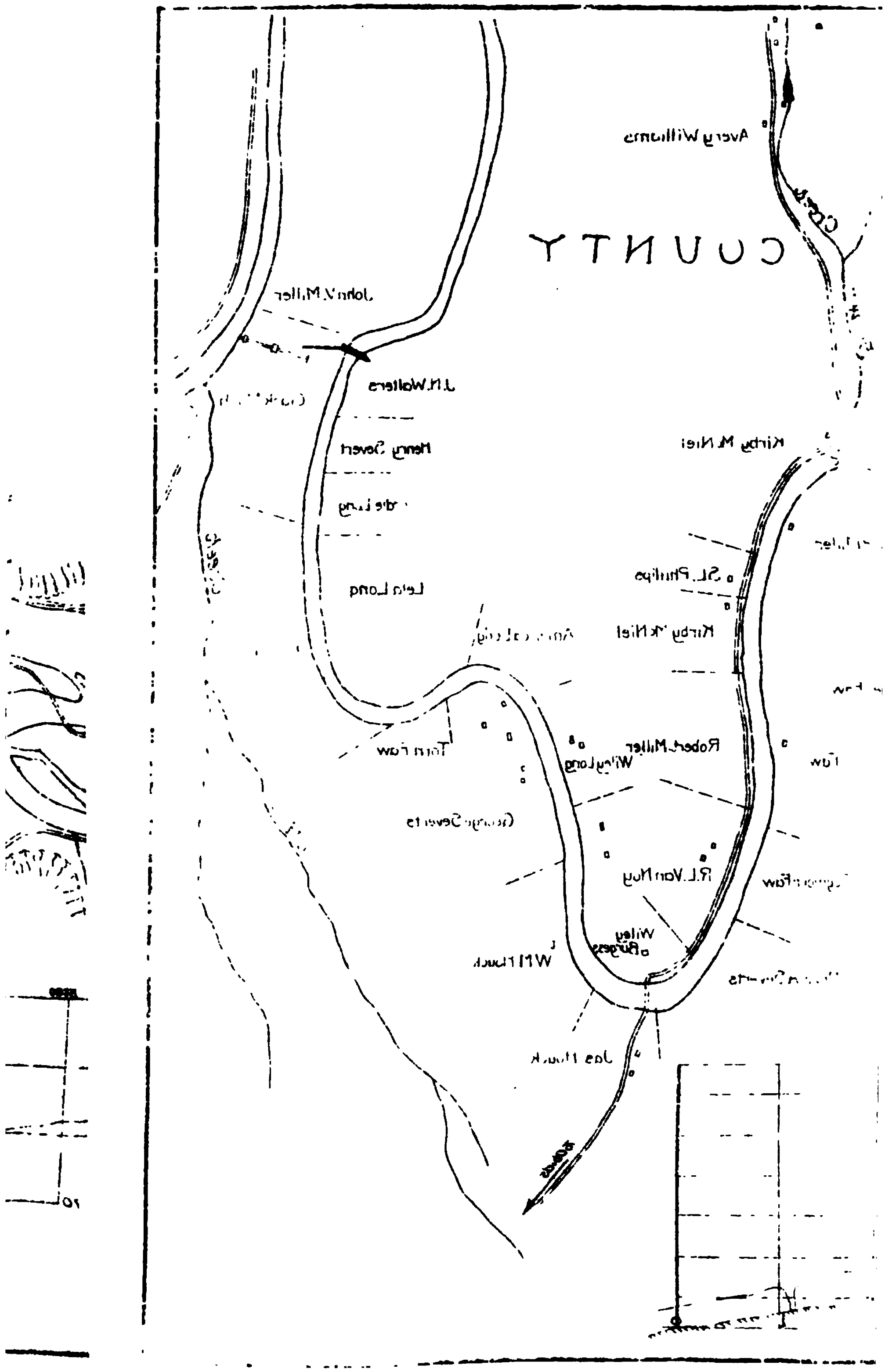
PROFILE OF STREAM-BED

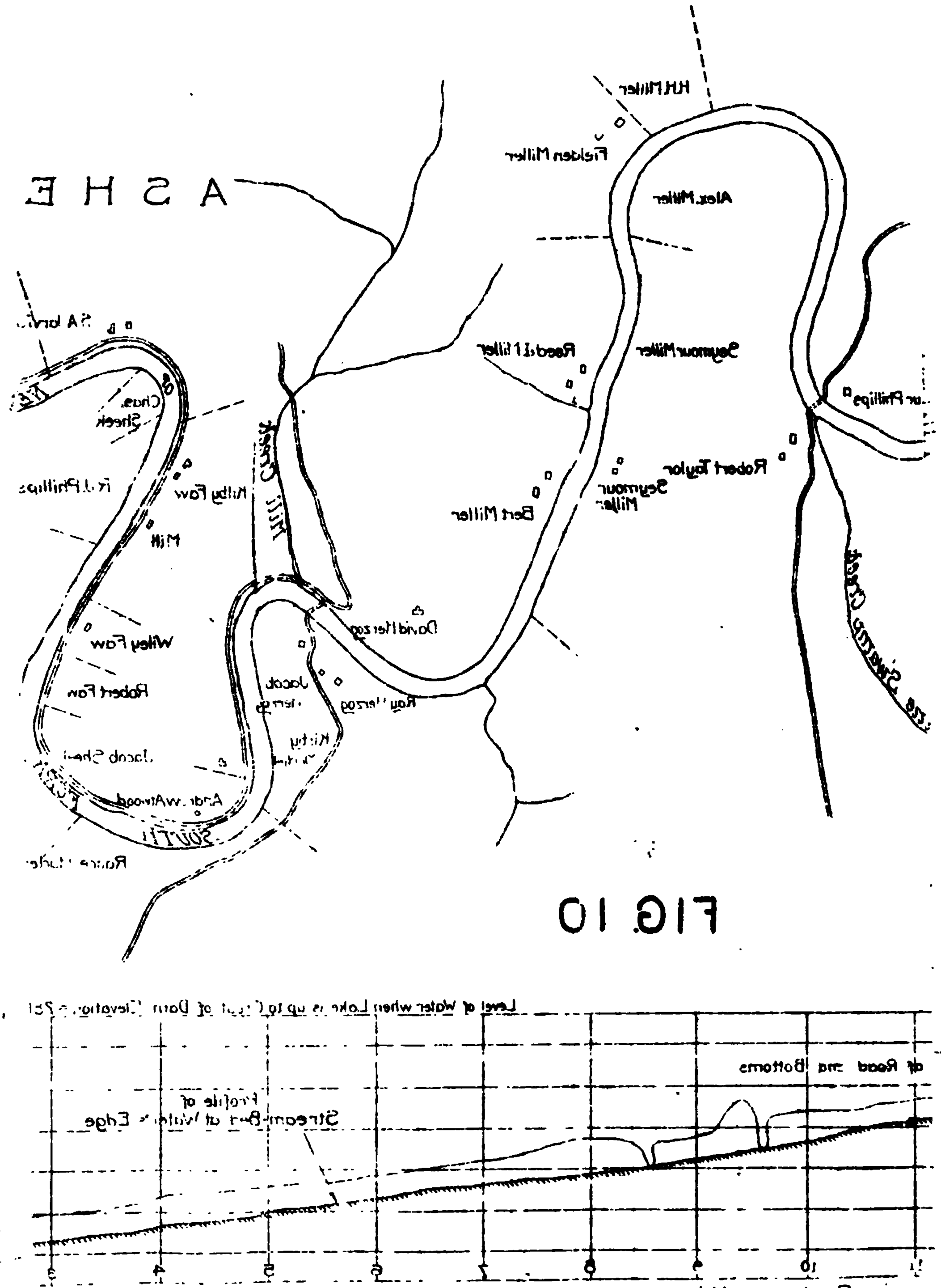
FIG. 10



Note: "Zero" point taken at Sta. 2746+87 of U.S. Engineers' survey. Original drawing in U.S. office at Wilmington, Ill.


Avery Williams
Creek
COUNTY
John V. Miller
J.N. Walters
Clark Mash
Henry Severt
Kirby McNiel
RIVER
Henry Severt
Virdie Long
R.P. Miller
S.L. Phillips
Creek
Lela Long
Kirby McNiel
America Long
T.B. Finley
Raymer Faw
Isaac Faw
Robert Miller
Wiley Long
Tom Faw
George Severts
Obid's
Seymour Faw
R.L. Van Noy
Wiley Burgess
W.M. Houck
Mrs W.A. Severts
Jas. Houck


Avery Williams
COUNTY
John V. Miller
J.H. Wolters
Henry Severt
Lela Long
Kirby McNiel
S.L. Phillips
Kirby McNiel
Robert Miller
Wiley Long
Tom Fow
George Severts
R.L. VanNuy
Wiley Burgess
W.H. Houck
Jas Houck



ASHE
H.H. Miller
Fielden Miller
Alex Miller
Reed Miller
Seymour Miller
Robert Taylor
Seymour Miller
Bert Miller
Chas. Sheek
Kilby Fow
Mill
Wiley Fow
Robert Fow
David Herzog
Jacob Herzog
Roy Herzog
Mill Creek
South
Level of Water when Lake is up to Crest of Dam
Bottoms
Profile of Stream Bed at Water's Edge
3
4
5
6
7
8
9
10
11
Scale in Miles

FIG 10

Table 6a has been prepared from Figure 2, giving the number of years in which gage heights of stated magnitude may be expected to be equaled or exceeded. An attempt has also been made to evaluate these gage heights in terms of flood discharge for the Cape Fear at Fayetteville. This data is shown also in Table 6a, but is at best inaccurate, although presenting what are believed to be reasonable estimates. There is also given in Table 6a the flood flows to be expected by application of Fuller's general formula, $Q = CA\ (1 + .8 \log T)$, using the value of $C = 54$.

It should be stated, however, that Fuller derives his coefficient C from flood data which, as mentioned previously, are incorrect, and consequently the figures given by this formula are too large due to C being too great. The data given by the formula, however, are on the safe side.

The records of flood discharge on the Deep River at Moncure cover only the years 1898 and 1899. The maximum flood occurred in February, 1899, and discharged at a rate of 17.5 second feet per square mile as compared to 12.2 second feet per square mile for the same flood at Fayetteville. This was the fourth largest flood ever recorded at Fayetteville, and the ratio of the unit discharge at Moncure to that at Fayetteville is 1.44. It is believed that a factor of 2.0 is safe to apply to the unit values given in Table 6a to obtain estimates of flood discharge on the lower reaches of Deep River. Fuller's formula cannot be used directly here, unless a value of C greater than 63 is assumed. The discharge data for Deep River do not cover a sufficiently long period to enable C to be computed.

On the upper Deep River no flood measurements have been made. The present gaging station at Ramseur has a well defined rating curve up to 9 feet. This curve has been extended to 25 feet, the height reached by the 1908 flood. A flood of about 80 second feet per square mile is indicated by this extension, and the flood was probably of about that magnitude. As compared with not more than 30 second feet per square mile at Fayetteville for the same flood, the ratio is about 2.7.

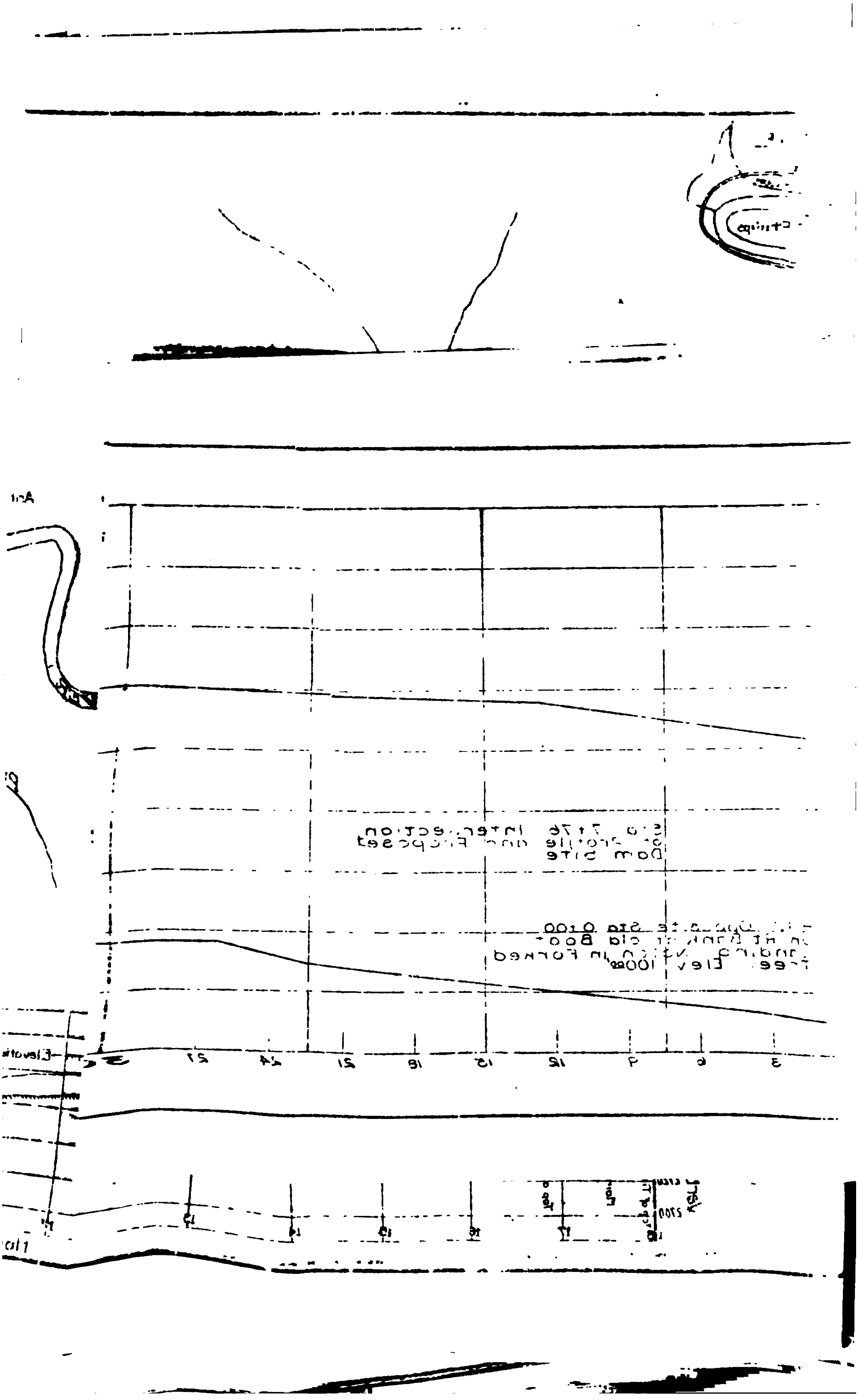
From the preceding analysis of flood data, Table 6b has been prepared, giving estimates of probable flood discharges on the Deep River. It is recommended that at least the largest values given be used for design of spillways for dams.

Attempts have been made by both the State Highway Commission and the Survey to estimate flood flows on Deep River by slope and area methods from heights asserted to have been reached by the 1908 flood. The Survey has not been able to discover any results from these investigations which it feels are accurate enough to serve in any degree as a basis for estimating flood flows. A detailed study of flood flows on the Cape Fear River System will be found in Bulletin 38 of the Survey.

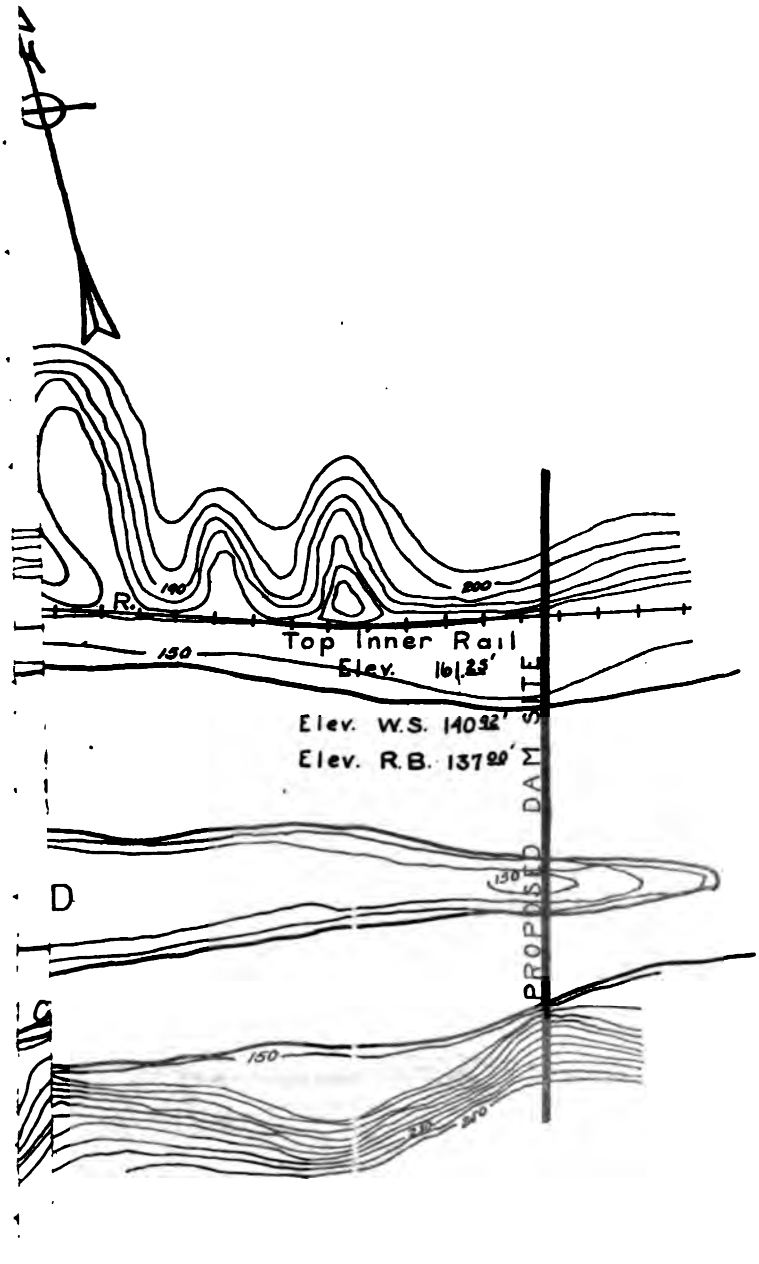
FIG. 11

NORTH CAROLINA
GEOLOGICAL AND ECONOMIC SURVEY
JOSEPH HYDE PRATT — DIRECTOR
THORNDIKE SAVILLE — HYDRAULIC ENGINEER

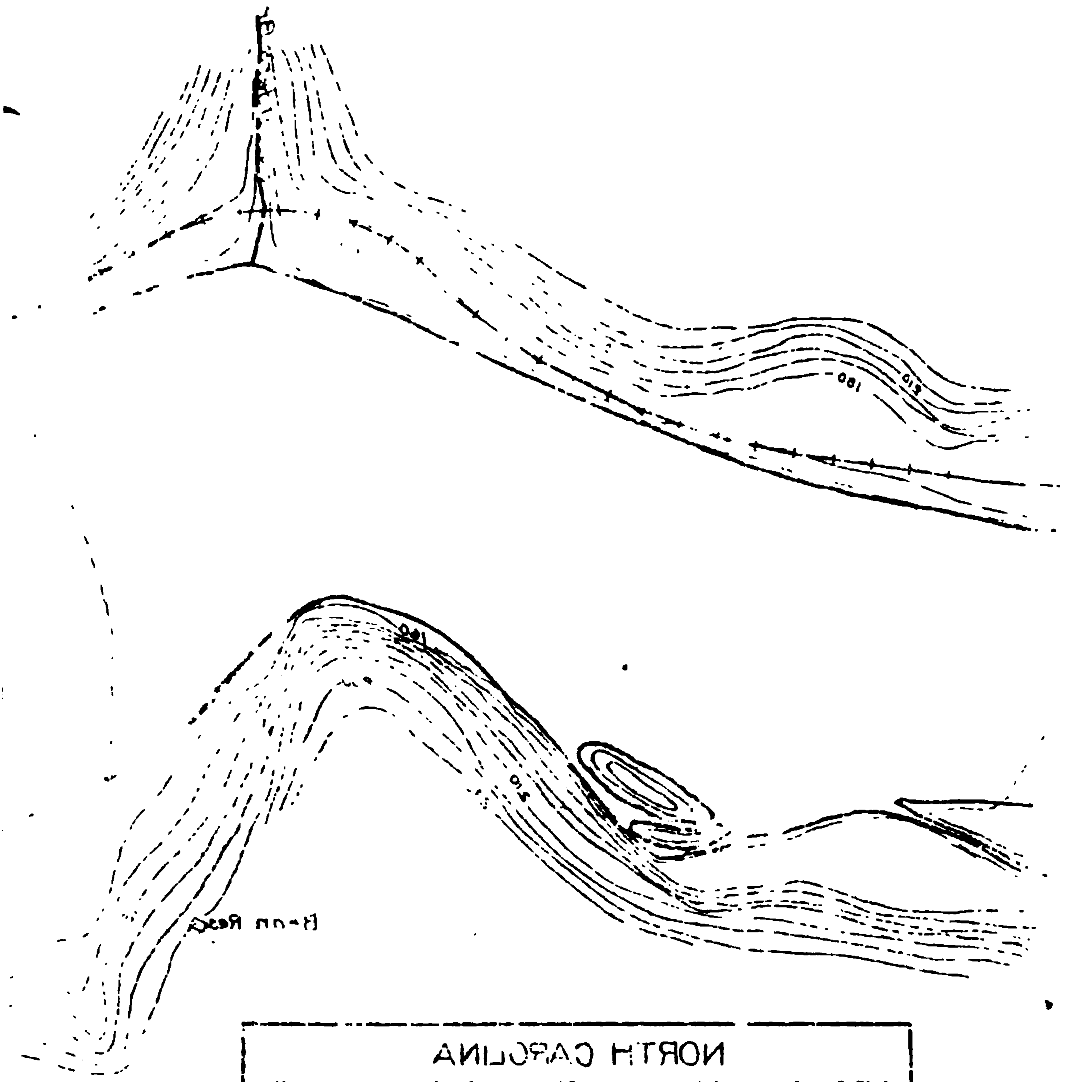
PROFILES OF
YADKIN RIVER AND SOUTHERN RAILROAD
FROM FOOT OF BEAN SHOALS
TO MARTIN'S FERRY
Serial No. 1



Sta 7+76 Intersection of Profile and Proposed Dam Site
3
6
9
12
15
18
21
24
27



R.
190
200
150
Top Inner Rail
Elev. 161.25'
Elev. W.S. 140.92'
Elev. R.B. 137.20'
PROPOSED DAM SITE
130
D
150



NORTH CAROLINA

GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT ~ DIRECTOR

THORNDIKE SAVILLE ~ HYDRAULIC ENGINEER

TOPOGRAPHIC MAP

OF

BEAN SHOALS ON YADKIN RIVER

SCALE IN FEET

0 500 1000 1500

CONTOUR INTERVAL ~ 10 FEET

Serial No. ~ 1-C

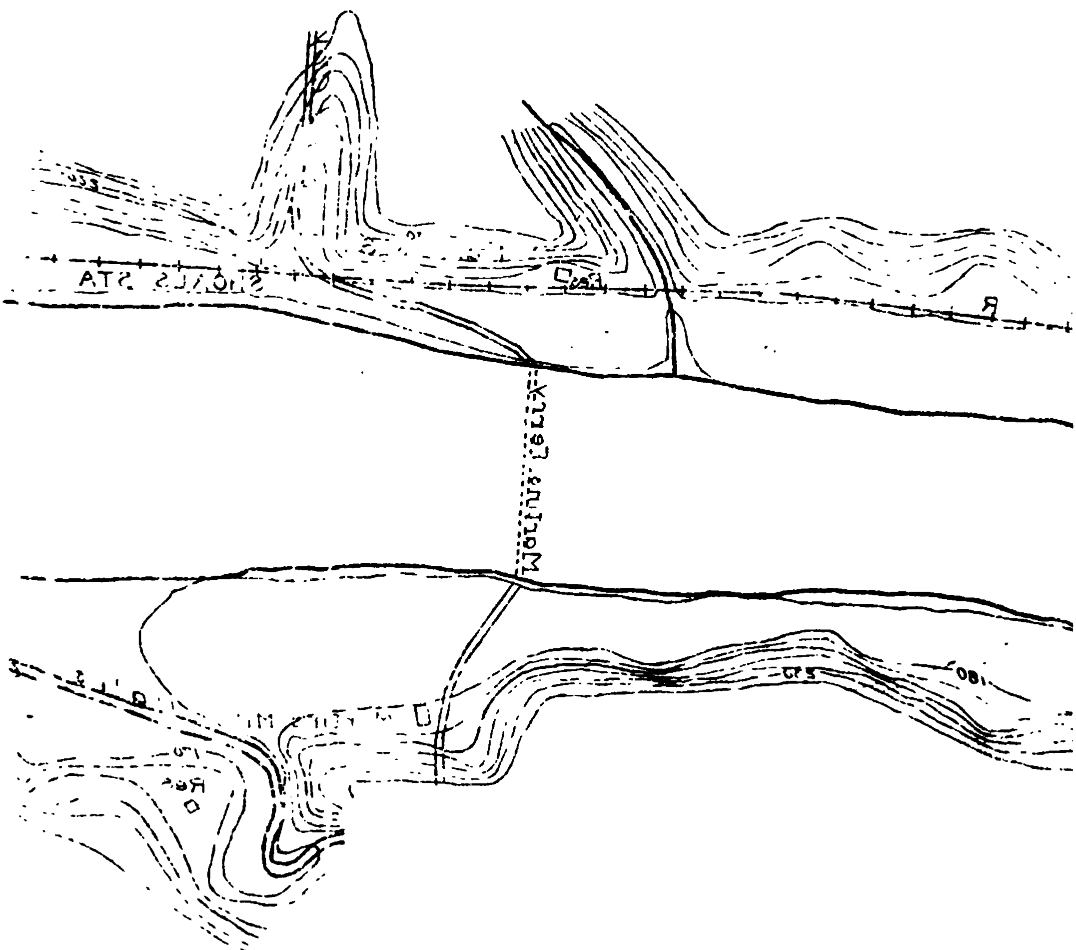
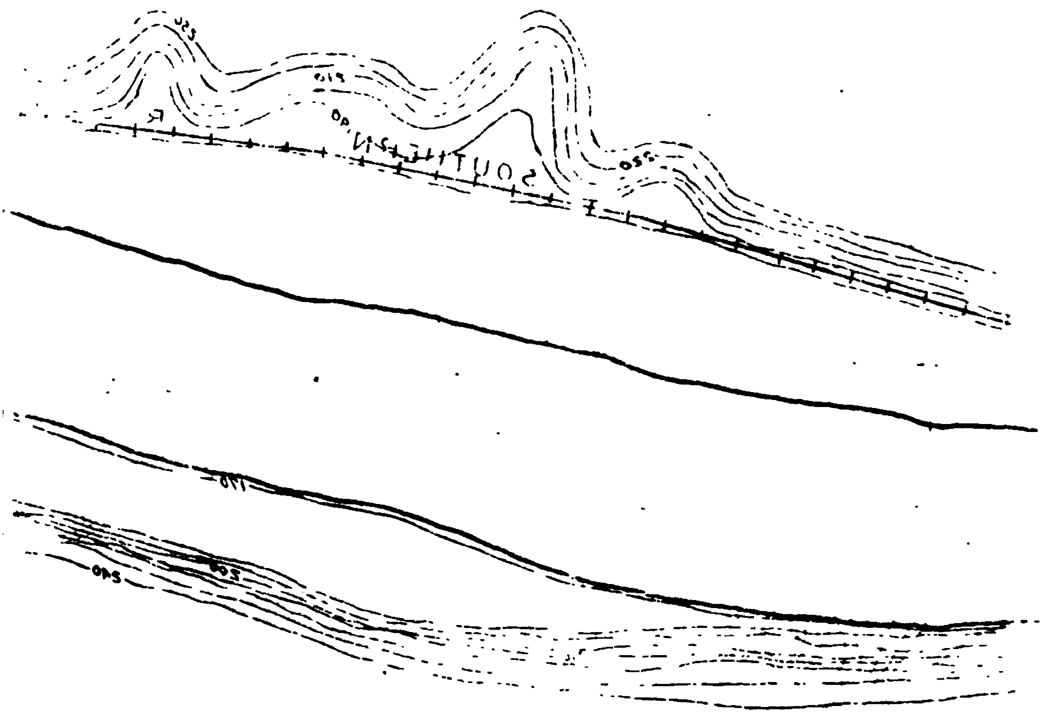
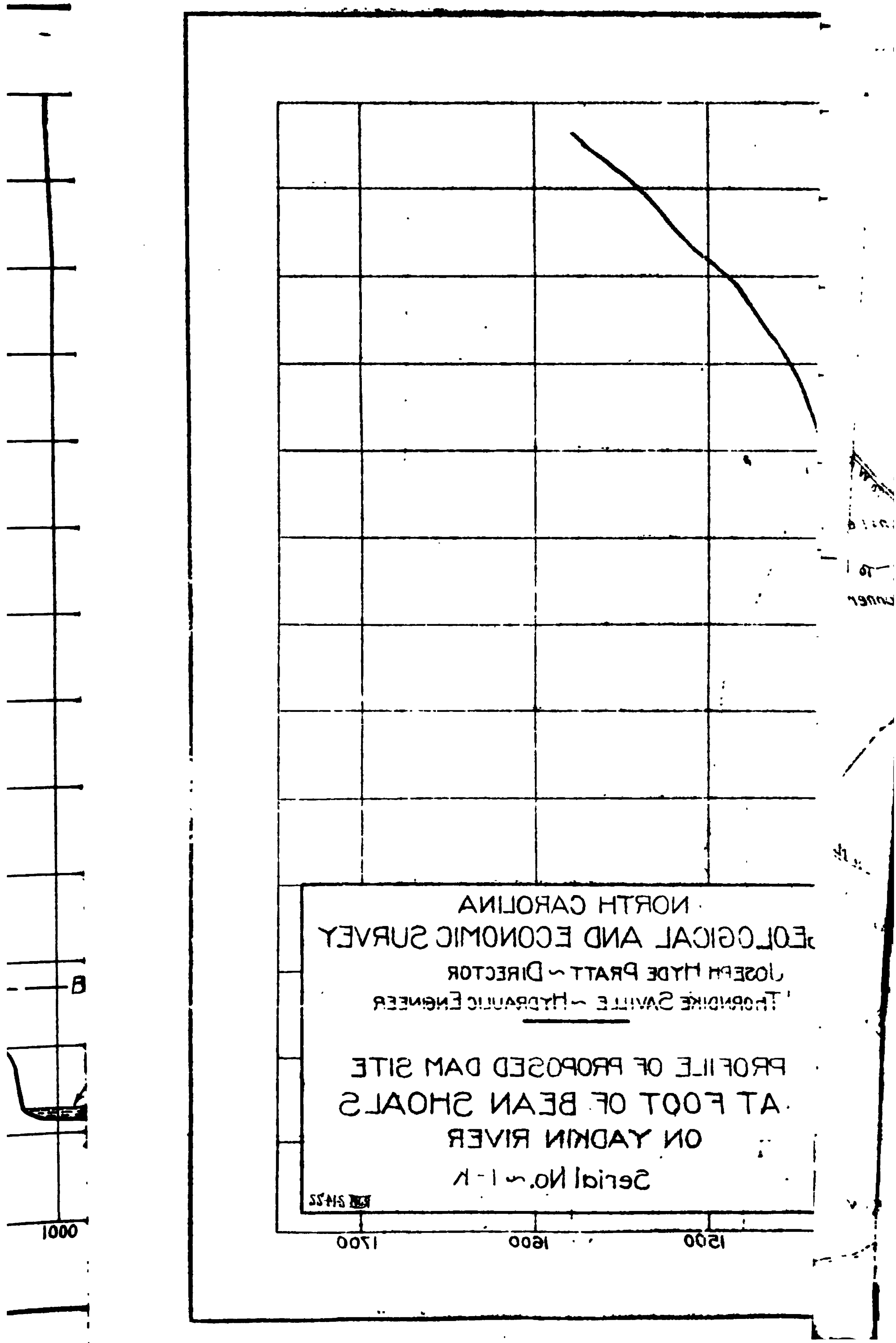
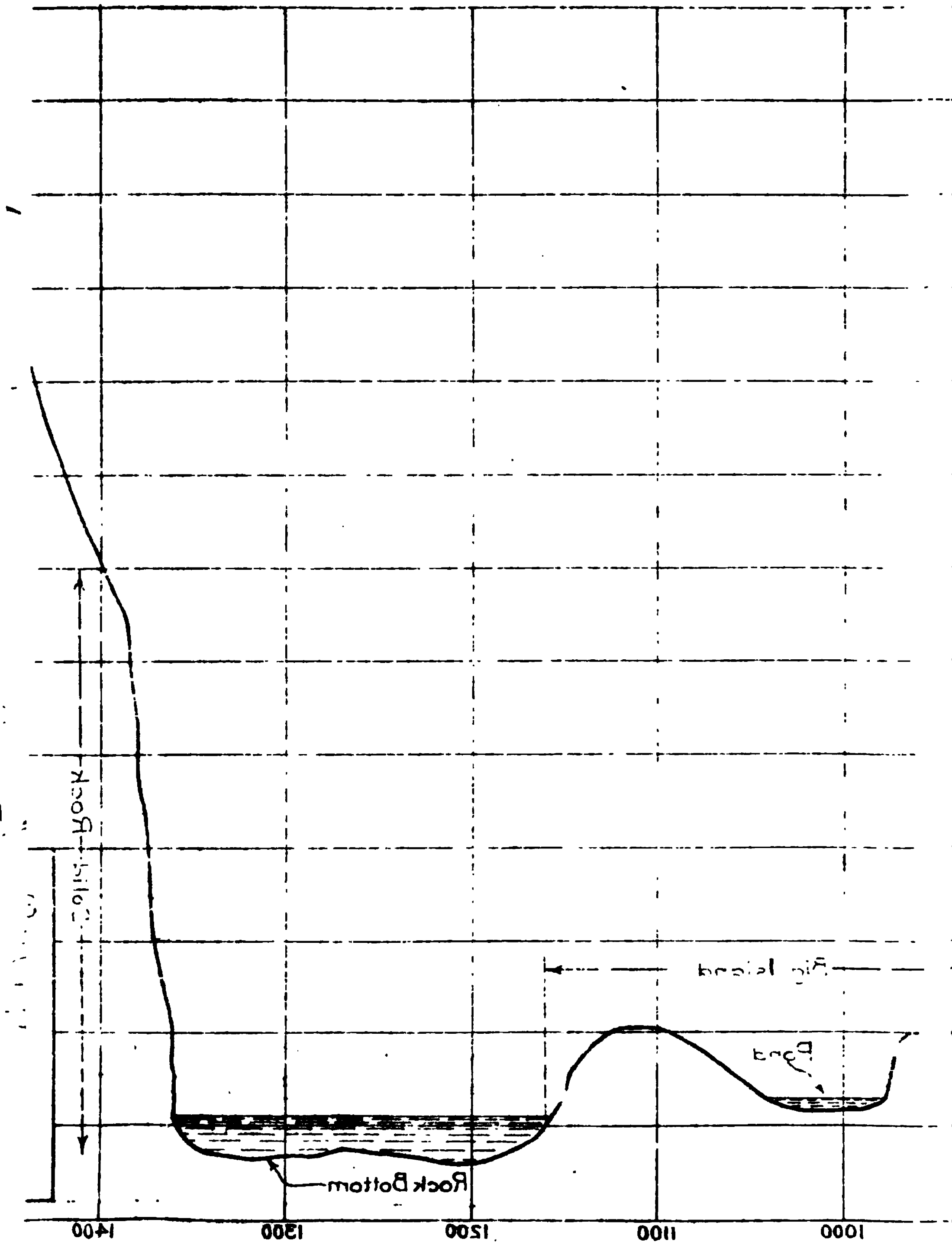
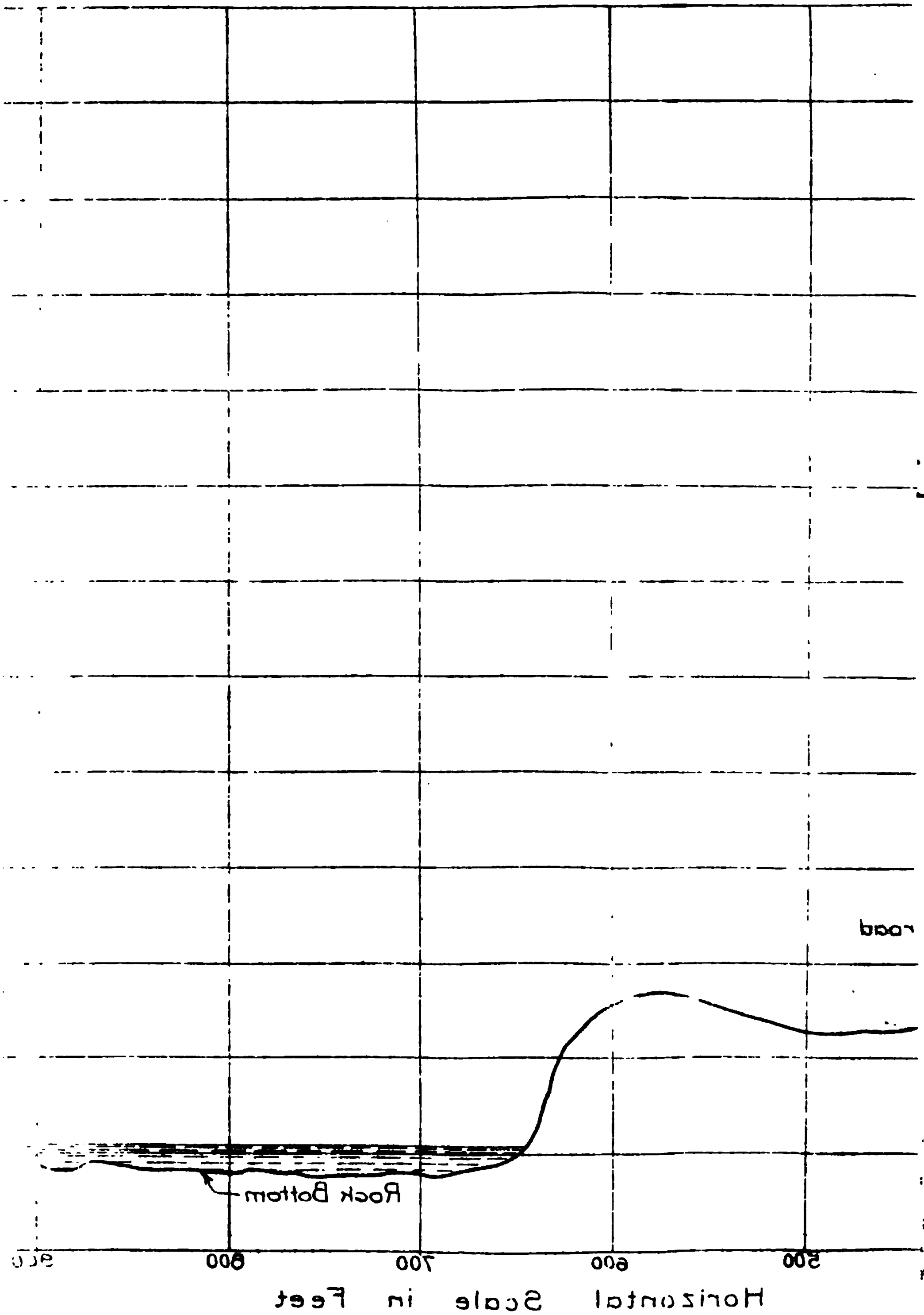


FIG. 12




NORTH CAROLINA
GEOLOGICAL AND ECONOMIC SURVEY
JOSEPH HYDE PRATT ~ DIRECTOR
THORNDIKE SAVILLE ~ HYDRAULIC ENGINEER
PROFILE OF PROPOSED DAM SITE
AT FOOT OF BEAN SHOALS
ON YADKIN RIVER
Serial No. ~ I - A
1700
1600
1500
1000
B


Rock Bottom
1400
1300
1200
1100
1000


road
Rock Bottom
900
800
700
600
500
Horizontal Scale in Feet

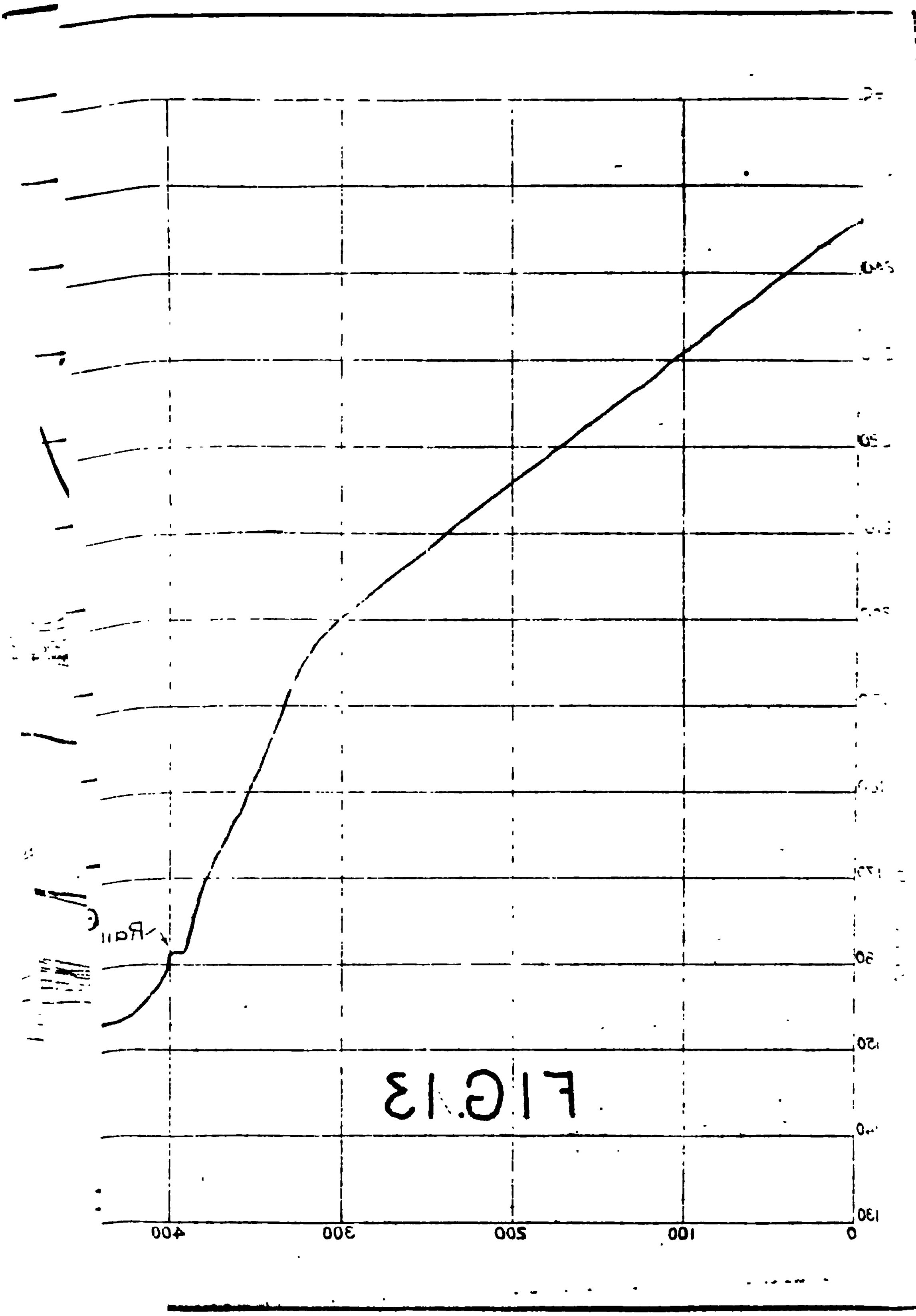
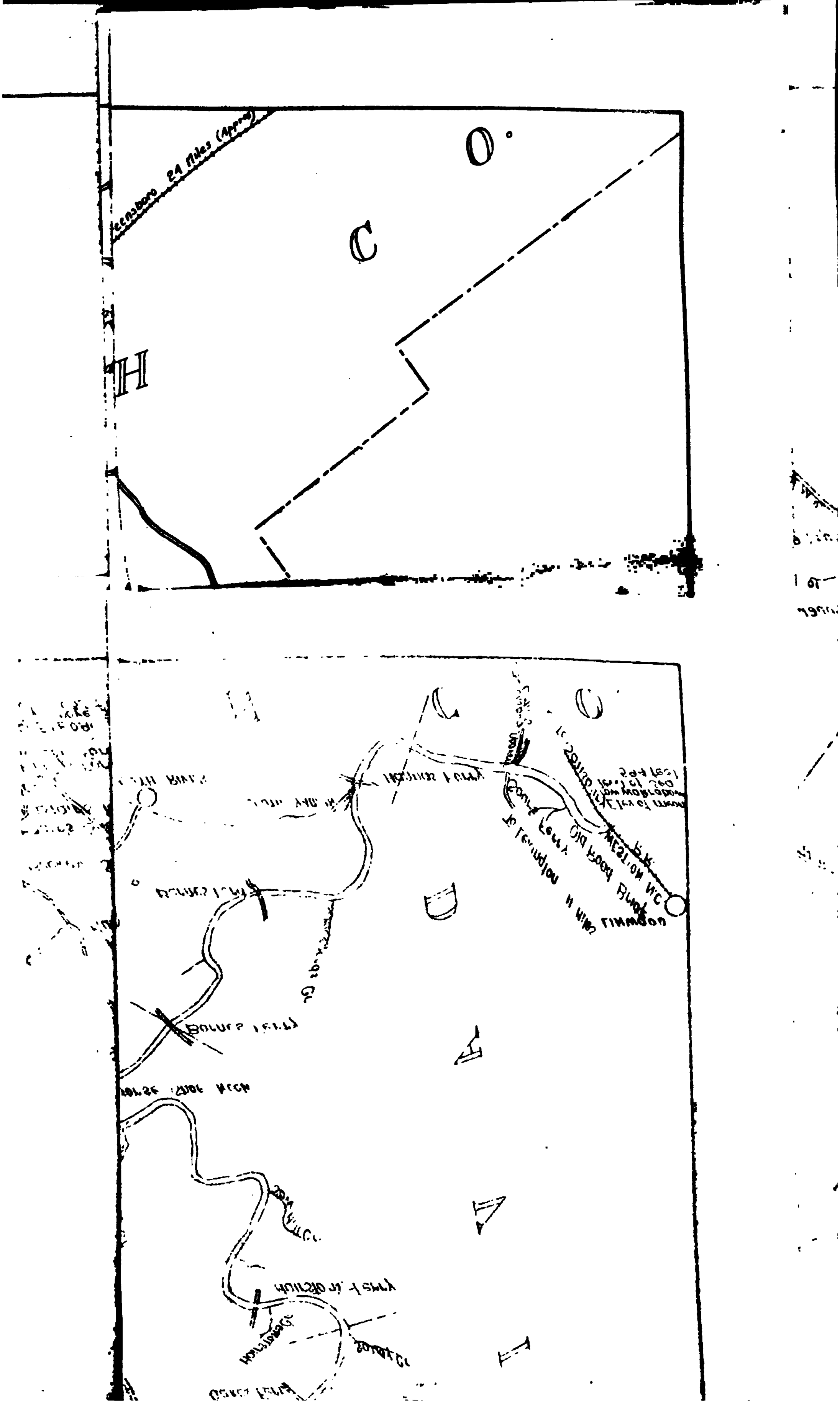
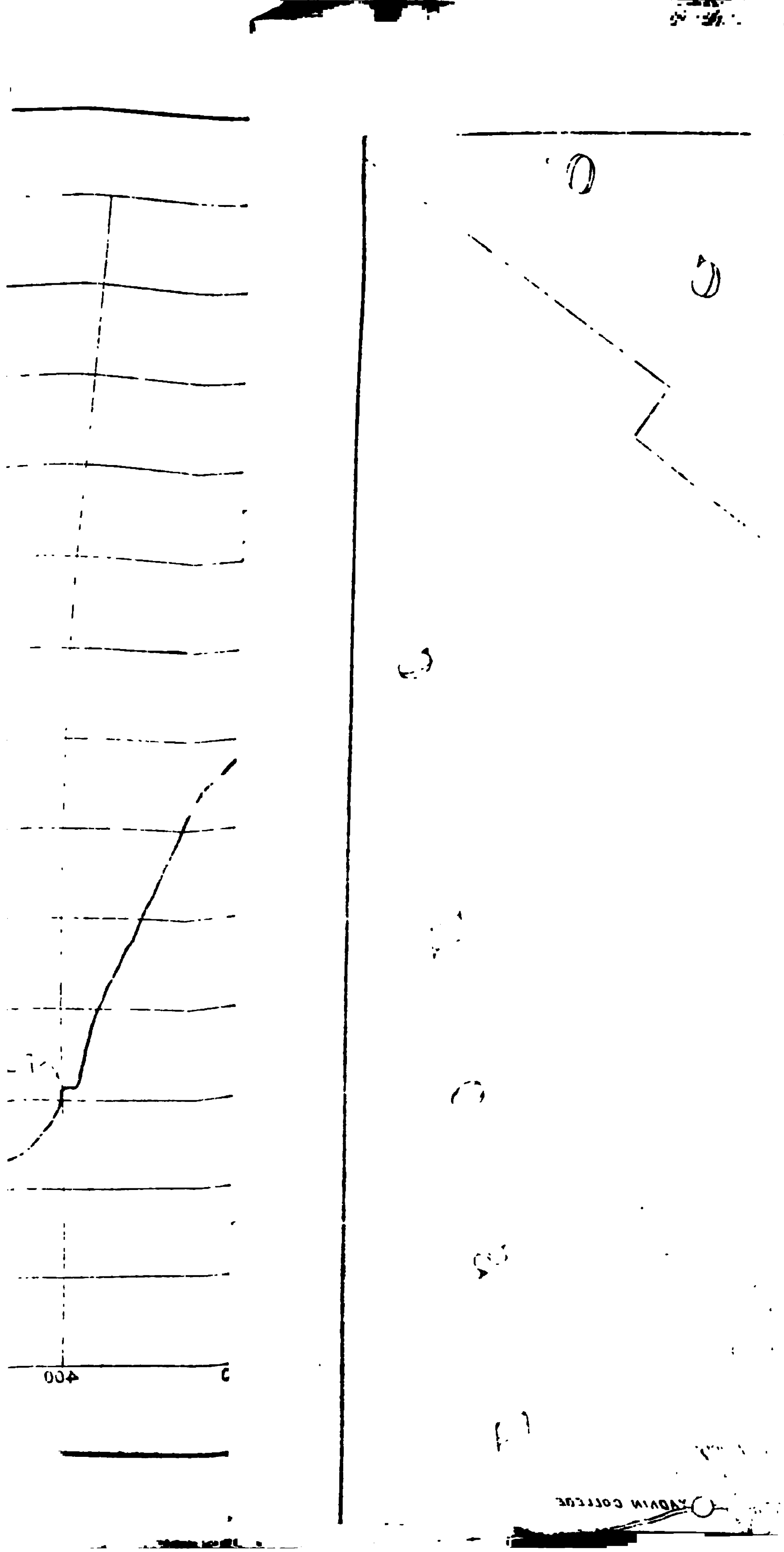
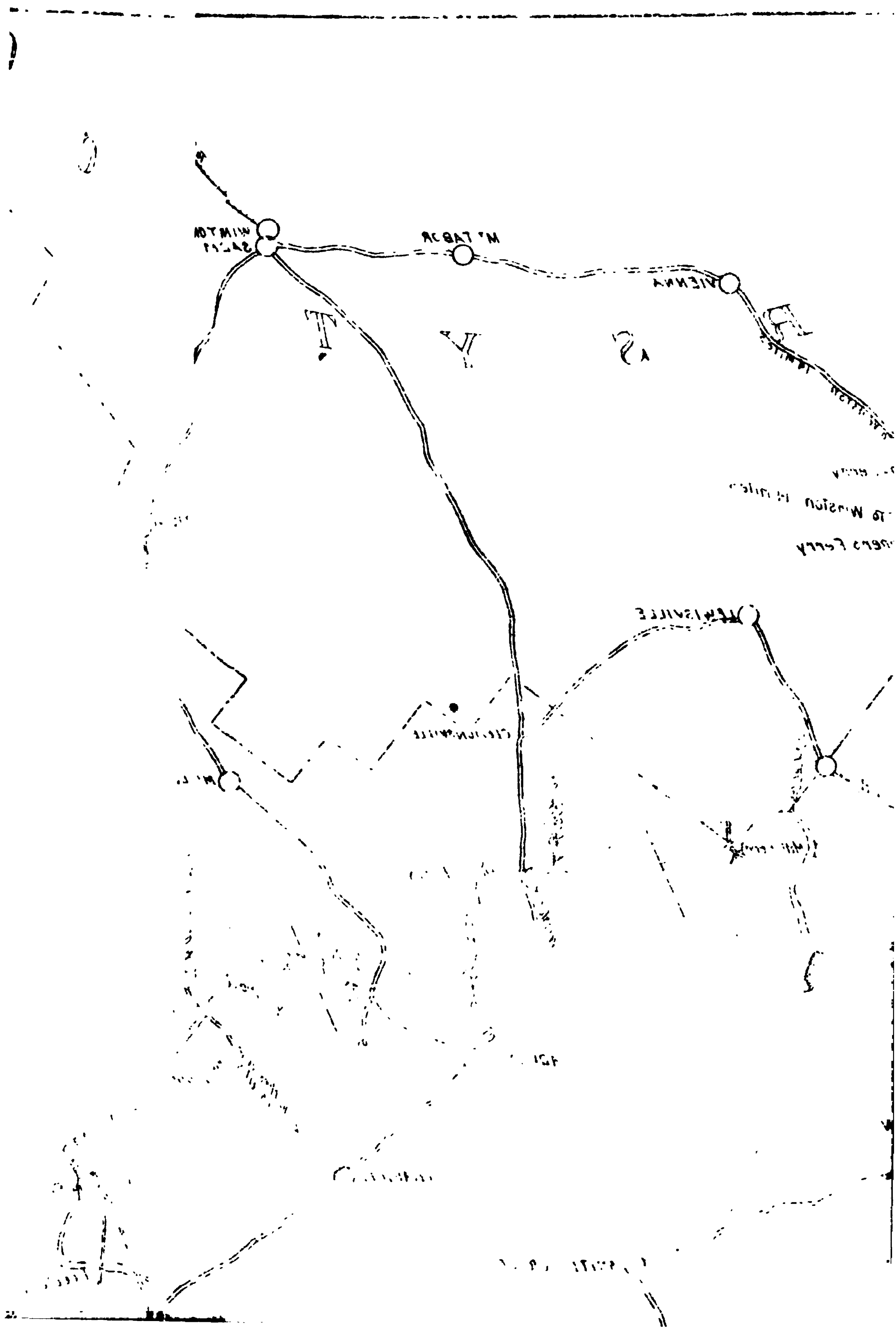


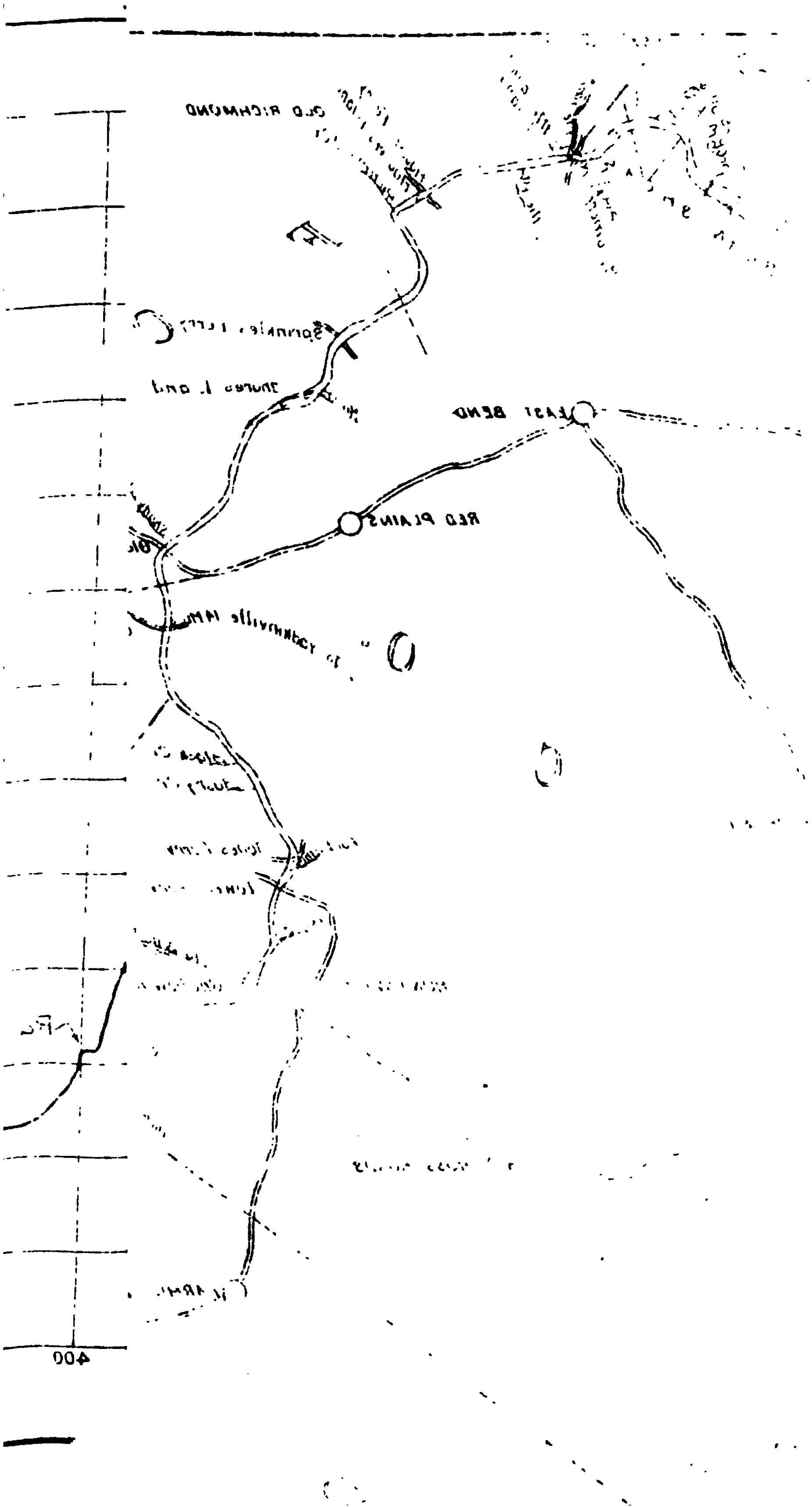
FIG. 13

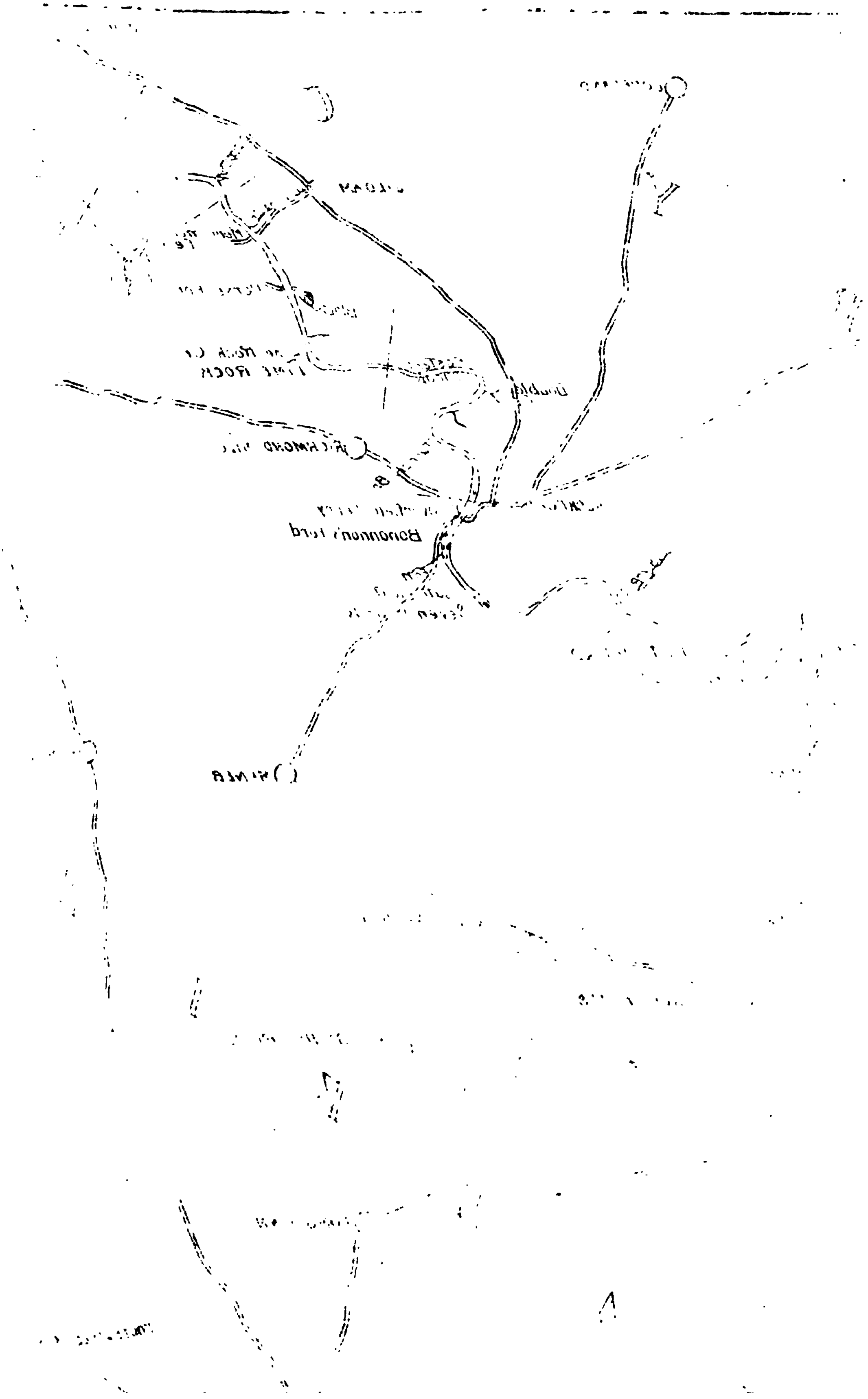


eensboro 24 Miles (Approx)


400
YADKIN COLLEGE

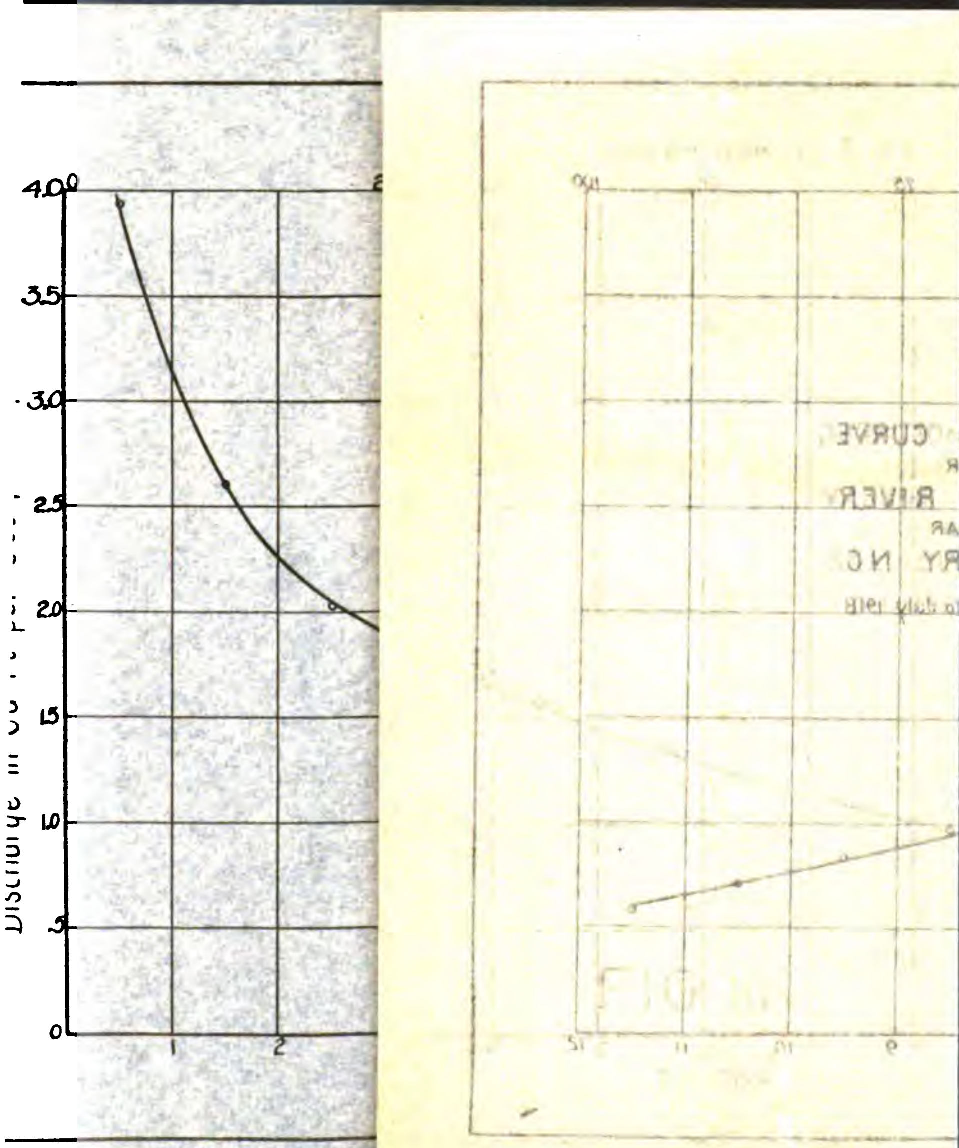



OLD RICHMOND
EAST BEND
RED PLAINS
400


Bohannon's Ford

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY

JOSEPH HYDE PRATT, DIRECTOR (UNTIL MARCH, 1924)
BRENT S. DRANE, DIRECTOR (SINCE MARCH, 1924)



EDWARDS & BROUGHTON PRINTING COMPANY
1924

TABLE 11.—SUMMARY OF WATER POWER SITUATION ON DEEP AND ROCKY RIVERS

1	2	3	4	5	6	7	8	9	10	11
	Fall Developed in Feet	Present H. P. Installed	Present Primary Horse Power		Primary H. P. With All Developments		Secondary H. P. 60% of Time† at Present		Secondary H. P. 60% of Time With All Developments	
			24-Hour	10-Hour	24-Hour	10-Hour	24-Hour	10-Hour	24-Hour	10-Hour
Present Water Power Installations*	254	5,787	1,087	2,611	2,806	6,730	4,360	10,460	2,879	6,920
Proposed Water Power Installations	295				5,096	12,230			3,362	8,068
Total for Deep River	549	5,787	1,087	2,611	7,902	18,960	4,360	10,460	6,241	14,988
Rocky River. Present and Proposed	55	240	60	144	262	528	237	570	533	1,386
Grand Total	604	6,027	1,147	2,755	8,164	19,488	4,597	11,030	6,774	16,374

*Includes only those present installations not flooded out by proposed new developments.

†Secondary power is defined as that power in excess of the primary power and available 60% of the time in the average year.

VI

STEAM POWER AUXILIARY

To develop any such "flashy" stream as Deep River to its maximum economic capacity involves the use of steam power to supplement the water power during periods of deficient flow. This is true even though considerable regulation by storage is possible, since it is very rarely indeed that there is sufficient storage available to utilize even 70 or 60 per cent of the total annual flow. Tables 8 and 9 indicate what the river is capable of producing with and without storage. These two tables are summarized in Table 11. It is evident that present installations are far in excess of primary power available. Consequently, if mills are run during low-water season, steam auxiliary is necessary. Nearly every mill has a steam plant for this purpose, and in several instances the plant runs entirely on steam in dry seasons.

Table 11 shows that with the Deep and Rocky rivers fully developed there will be available for seven months of the average year about 6,774 24-hour or 16,374 10-hour h. p. over and above the 8,164 primary 24-hour power.* To utilize this for industries or public utility service which requires all-the-year power, steam auxiliary of the same amount would be needed. In other words, to develop the river to supply a constant demand of about 15,000 24-hour or 26,500 10-hour h. p. will require steam capacity of only 6,774 or 16,374 h. p. respectively. This steam capacity would, moreover, have to be utilized only about one-third of the time. It is entirely probable that when the load relations are studied, less steam capacity could be installed, peak loads being taken by the water-power plants.

There is at present installed on the river, and available for connection into any scheme of river development, the steam power indicated in Table 12. The plant capacities given are over and above the installed capacity required for plant process steam.

TABLE 12

Oakdale	200 h. p.
Randleman	600 h. p.
Cedar Falls	200 h. p.
Franklinville	200 h. p.
Ramseur	200 h. p.
Gulf	2,000 h. p.
Total	3,400 h. p.

*This assumes that storage is utilized on the "insurance method" and that reservoirs are not drawn down below 25 per cent of their depth. In actual operation, after a few years experience, it would become possible to utilize this storage at greater rates than by the rather inefficient insurance method, and also it would be possible to utilize storage at Randleman and Howards Mill below the 25 per cent level in very dry periods. Thus by shutting down the Randleman power plant and drawing down the Randleman reservoir, 17 second feet additional could be delivered over some 400 feet fall equivalent to 618 primary horsepower, less the loss of 230 horsepower at Randleman, or a net gain of some 380 horsepower. This sort of operation of the reservoirs can not be forecast, but must be based upon operating experience. It is mentioned here merely to indicate that the figures as to primary power utilized in the report, and based upon the "insurance method" of utilizing storage, may be exceeded in practice.

Old Lock, now foundation of power house, Moncure

Power House, Moncure

THE OLD AND THE NEW

NORTH CAROLINA GEOLOGICAL AND ECONOMIC SURVEY
JOSEPH HYDE PRATT, DIRECTOR (UNTIL MARCH, 1924)
BRENT S. DRANE, DIRECTOR (SINCE MARCH, 1924)

ECONOMIC PAPER No. 54

WATER-POWER INVESTIGATION OF DEEP RIVER

BY
THORNDIKE SAVILLE, HYDRAULIC ENGINEER

RALEIGH
EDWARDS & BROUGHTON PRINTING COMPANY
1924

GEOLOGICAL BOARD

LETTER OF TRANSMITTAL

CHAPEL HILL, N. C., May 20, 1924.

To His Excellency, HON. CAMERON MORRISON,

Governor of North Carolina.

SIR:—The appended report on the Water-Power Investigation of Deep River, North Carolina, by Thorndike Saville, Hydraulic Engineer, was initiated under the directorship of Col. Joseph Hyde Pratt. It has been reviewed by the present Director, and it is recommended for publication as Economic Paper No. 54 of the publications of the North Carolina Geological and Economic Survey.

It is believed that this report, in addition to its local value, has unusual economic value of general application, as an object-lesson as to the great conservation of this important resource which may be obtained by more thorough application of modern scientific knowledge.

Very respectfully,

BRENT S. DRANE,

Director.

CONTENTS

LIST OF TABLES

INDEX TO ILLUSTRATIONS

PLATES

FIGURES

WATER-POWER INVESTIGATION OF DEEP RIVER

By THORNDIKE SAVILLE*

SUMMARY

1. A complete power study of Deep River is presented, based on field work comprising a river profile and traverse, cross-sections of dam sites, storage studies, and estimates of power which may be developed.

2. The total fall from crest of a proposed 40-foot dam near Jamestown to the mouth of Deep River at Moncure is 612 feet in 114 miles. The fall now developed is 302 feet. Of the 310 feet now undeveloped the report indicates how 247 feet may be economically developed, utilizing 90 per cent of the total fall on the river.

3. Stream-flow studies indicate very low unit discharge in the fall months. This may be considerably augmented by storage reservoirs. Three such reservoirs, with dams 40, 50, and 60 feet high respectively, are recommended. They would serve to increase the low-water flow about 300 per cent.

4. Investigation of silting in existing power ponds indicates that at many present plants more than half the available power is lost through inability to store the night flow. Silt removal methods are considered.

5. The primary and secondary water power which can be developed at existing and recommended developments is discussed. At present 279 feet fall is developed on Deep and Rocky rivers, with 1,147 24-hour primary horsepower and 4,597 24-hour 7 months secondary horsepower theoretically available. If the rivers are fully developed in accordance with the scheme recommended, 604 feet fall will be utilized, and there can be produced 8,160 24-hour primary and 6,774 24-hour secondary horsepower. This is equivalent to 19,490 10-hour primary and 16,370 10-hour secondary horsepower.

6. By use of mouth-of-mine steam auxiliary stations at the Deep River Coal Fields, there may be produced 15,000 continuous 24-hour horsepower. The steam plants would have to be used only about one-third of the time.

7. The results outlined can only be obtained economically by interconnection of all water and steam power plants to form a local super-power system. This system must be operated as a unit. A scheme is indicated whereby the various power interests on the river could combine to form a single organization to effect these ends.

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I

INTRODUCTION

ORIGIN AND PURPOSE OF REPORT

During the summer of 1922 Major Warren E. Hall, then District Engineer of the United States Geological Survey, and the writer, made a brief field reconnaissance of the water-power situation on Deep River. As a result of this investigation a report was prepared by the writer and sent to the various mill and power interests along the river, pointing out (1) that the present developments were seriously handicapped by lack of water in the dry months every year; (2) that additional power was needed for existing and future demands; (3) that it was evident there were several good undeveloped power sites which could be developed both for power and to provide much needed regulation in dry periods; and (4) that studies were desirable to indicate methods for the removal and control of silting in the power ponds, since at several developments there was not even over-night pondage, due to silting.

At a meeting of the power interests on Deep River, called by the Survey in Greensboro in August, 1922, to consider this reconnaissance report, a coöperative agreement was entered into between these interests and the North Carolina Geological and Economic Survey, whereby the Survey agreed to conduct a detailed study of the power situation on the river, and to prepare a report containing a scheme for the entire development of the river as a unit, considering especially the various factors referred to in the reconnaissance report. The power interests agreed to bear one-half the estimated cost of the work, the remainder to be borne by the Survey.

The Deep River power interests who have coöperated in this investigation are as follows:

Company	*Location of Plants*	*Main Office*
Oakdale Cotton Mills	Oakdale	Oakdale
Deep River Mills	Randleman	Randleman
Leward Cotton Mills	Worthville	Worthville
Central Falls Mills	Central Falls	Central Falls
Sapona Cotton Mills	Cedar Falls	Asheboro, N. C.
Columbia Mfg. Company	Ramseur	Ramseur
Sandhill Power Company	Carbonton	Lakeview
Deep River Power and Light Company	Moncure	Troy
Carolina Power and Light Company	Buckhorn (Cape Fear River)	Raleigh

During the summer of 1922 an agreement was made with the county commissioners of Moore County for a coöperative investigation of the water powers of that county. Some field work was done that summer, and has been utilized in preparing the present report. The publication of a report on the water powers of Moore County was held up pending the more elaborate study of the entire river in 1923, inasmuch as all the undeveloped water power of any magnitude in Moore County was located on Deep River. The county commissioners of Moore County have thus also coöperated in the investigations considered in this report.

SCOPE OF REPORT

Field work on the Deep River investigation was carried on during the summer of 1923. A complete river profile and traverse of the river was made, cross-sections of undeveloped dam sites were obtained and pond lines were run at selected dam sites where storage would be a factor. Two stream-gaging stations were established, and have been in continuous operation, one since November, 1922, and the other since July, 1923. Field observations on the amount of silt in power ponds have been made, together with studies on methods of removing silt from the ponds and controlling its deposition. The existing power installations and transmission systems along the river have been carefully studied, and complete data obtained concerning their power equipment.

The present report analyzes the foregoing data and presents a comprehensive plan for the development of the entire river, looking toward the interconnection of present and future hydro and steam plants on the river. The plan outlined contemplates that the entire river should be developed for maximum efficiency and operated as a unit to supply the power demands of the towns and industries in its vicinity. This is the first complete river investigation to be made in North Carolina, and the second in the South to consider the linking up of existing manufacturing power interests along a river, together with the ultimate development of that river. It is believed that the present investigation is unique in the measure of coöperation between a state organization and a group of independent manufacturing interests for the maximum utilization of local state resources in coal and water power. A general map of the region, reduced from United States Soil Maps, is shown on Plate I. On this map there is indicated present and proposed hydro-electric and central steam stations, the existing and proposed transmission lines, and the location of the Deep River Coal Fields.

PERSONNEL

The investigation has been carried on under the direction of Thorndike Saville, Hydraulic Engineer of the Survey. Mr. O. E. Martin

was in charge of the field parties and has prepared most of the maps and diagrams contained in the report. Mr. G. Wallace Smith has assisted in the computations. Messrs. G. A. Ausband, T. W. Cox, T. H. Andrews, and C. L. Jones were members of the field parties. Prof. J. E. Lear, of the Engineering School of the University of North Carolina, has been consulted on the transmission problems.

II

LOCATION AND DESCRIPTION OF DEEP RIVER

The Deep River rises in Forsyth and Guilford Counties, the East and West forks uniting a short distance above the highway bridge on the Greensboro-High Point highway, about one mile northwest of Jamestown. The river proper begins at this point and flows in a general southeasterly direction through Guilford and Randolph counties (Plate I) to the Randolph-Moore County line. From there it flows almost due east to Carbonton, and thence in a northeasterly direction to Moncure, where it unites with the Haw to form the Cape Fear River.

The Deep River rises in the granite and gneissic areas of the Piedmont Plateau, reaching the slate belt shortly after it enters Randolph County. It flows across this belt until it reaches Carbonton. This belt is composed of the older crystalline slates and shales, highly metamorphosed and with the strata at a high angle of inclination. The stream cuts across these upturned rocks, which vary greatly in character. Some are hard, others soft, giving rise to a succession of falls and rapids. The mill developments on the river from Randleman to High Falls have taken advantage of these conditions to construct dams developing from 10 to 15 feet fall. The ponds, therefore, are shallow, and in many instances quite filled with sediment. The causes of this are discussed later under silting.

Near Carbonton the river enters the more recent Jurassic and Triassic rocks, containing slates, sandstone, and coal. This portion of the river is adjacent to the Deep River coal fields. The proximity of these coal fields to the river is important in considering the interrelation of steam and water power along the river, and is discussed in more detail later.

The water-power developments in the slate belt noted above have all been for cotton mills. The region adjacent to the river is well adapted for raising cotton, the labor supply is good and transportation facilities are well supplied by railroads paralleling almost the entire length of the river at an elevation high enough to prevent interference with water-power developments.

In the lower portion the river flows through the famous "sand-hill" section, rapidly becoming a great fruit-growing region and resort center.

As will be seen from the map, Plate I, the region adjacent to Deep River is not industrialized, the existing mill developments being relatively small and independent. The entire region offers excellent opportunities for new cotton mills, canning industries, and manufacturing enterprises, requiring a supply of white native labor, good transportation, and cheap power. The combination of undeveloped water-power and cheap steam power, due to the adjacent coal fields, makes the present power situation along the river extremely attractive. It is the purpose of this report to point out how this power may be developed and utilized in the most economical manner.

III

FIELD WORK

PROFILE AND TRAVERSE OF DEEP RIVER

The survey of the river was begun at the junction of the East and West forks about a half mile above the highway bridge on the Greensboro-High Point road. Levels of the water surface were taken for the entire length of the river, and a traverse run from which the course of the river could be plotted. The resulting profile and traverse are shown on Plates II-V, inclusive.

Levels were started from the precise level bench mark of the United States Coast and Geodetic Survey at Jamestown and closed on a similar bench mark at Gulf. The error of closure was 0.68 foot, giving an accuracy very nearly equivalent to secondary leveling according to the standards of the United States Coast and Geodetic Survey. Greater accuracy was not attempted, as not necessary for the purpose of the survey, and therefore not warranting a greater expenditure of time. Bench marks were established on all highway and railroad bridges, being marked with white lead paint, as indicated in Figure 1. The profile is the only one ever run in the vicinity of the river and checked on standard bench marks. The elevations of the bench marks left by this survey, therefore, afford the first reliable elevations ever determined in many of the towns passed through. A list of the elevations correct to the nearest foot is given in Table 1.

TABLE 1

B. M. No.	Description	Elevation in Feet
1.	U. S. G. S. plug in large rock south of railway station, near old house at Jamestown, N. C.	792
2.	Nail in 10-inch ash tree 10 feet from the junction of the two prongs of Deep River, ½ mile above highway leading from Jamestown to High Point	732
3.	Iron bolt in southwest coping of Southern R. R. bridge across Deep River near Jamestown	739

TABLE No. 1—(*Continued*)

B. M. No.	Description	Elevation in Feet
4.	Large rock on left bank of Deep River, near water edge 75 feet below bridge at residence of Ingram. Approximate head of Oakdale pond	719
5.	On middle pier downstream side of highway bridge Oakdale, N. C.	708
6.	Left abutment upstream side of highway bridge at Chilton Mill	682
7.	On right abutment downstream side of highway bridge, just below Coltrane Mill	730
8.	Notch in foot of black oak at cross-roads on property of D. F. Davis	793
10.	Notch on foot of 2-foot locust tree left side of road 100 feet N.E. of Walker Mill	631
11.	Iron stake in concrete block at N.E. cornor of folding house, Deep River Mills	622
12.	On left abutment upstream side of highway bridge, at Deep River Mills, No. 2	604
13.	On right-hand downstream wingwall of highway bridge, Worthville	609
14.	On right abutment downstream side of highway bridge, Central Falls, N. C.	574
15.	On large ledge of rock about 20 feet behind store, Cedar Falls, N. C.	520
16.	On top of highest rock in yard of Randolph Mills, No. 1, Franklinville	479
17.	Notch in foot of 4-foot white oak on left bank of river 20 feet below old Roller Mill, Ramseur	444
18.	On large rock near forks of road leading to Buffalo bridge, property of L. W. Staley	529
19.	On left abutment downstream side of Buffalo bridge, 5 miles from Ramseur	436
20.	On corner of window-sill, Bank of Coleridge	424
21.	On right abutment upstream side of highway bridge, 3 miles from Bennett	364
22.	On left abutment upstream side of highway bridge at Howard's Mill	346
23.	On edge of buttress N.E. corner of mill building, High Falls	323
24.	On right abutment upstream side of Jackson's bridge, 1 mile below High Falls	294
25.	Notch in foot of 15-inch pine tree at cross-roads, Glendon	307
26.	On right abutment downstream side of highway bridge near Glendon	274
27.	On large rock near left end of dam, Carbonton	228
28.	Check on U. S. G. S. B. M. at Gulf	275.54*
29.	On left abutment upstream side of highway bridge, Gulf	238
30.	On left pier upstream side of A. & Y. R. R. bridge, near Cumnock	243
31.	On right abutment downstream side of highway bridge, near Cumnock	232
32.	On center pier downstream side of highway bridge, Lockville	184
33.	On root of 18-inch leaning sycamore tree left bank of Deep River at junction with Haw River	164

*U. S. C. and G. S. Bench at Gulf—Elevation, 276.22.

Stream-flow gaging station, Ramseur

Bench mark, Railroad Bridge, Jamestown

Figure 1

The profile and traverse, shown on Plates II-V, indicate the location of and fall at all developed water powers on the river, the location of and fall at all undeveloped sites recommended for development by this report, and the general fall of the river surface. The total fall from the crest of the proposed 40-foot dam at the forks above Jamestown (drainage area 55 square miles) to the mouth (drainage area 1,345 square miles) is 612 feet, in a distance of 114 miles. The fall now developed is 302 feet. Of the 310 feet now undeveloped, the scheme of development outlined in this report, and summarized in Table 8, will utilize 247 feet. The remaining 63 feet is used up in short falls between existing dams, in loss in power canals, in allowance for backwater, or in short stretches not susceptible of economic development.

Twenty feet of the undeveloped fall lies between Chilton Mill and Oakdale. The dam at Chilton Mill could readily be raised this amount, but would flood a number of highways, and the additional power is not regarded as commensurate with the cost. By the scheme outlined the river is to all practical purposes completely developed, by the utilization of 90 per cent of the total fall.

It should be noted that whereas at present 16 developments utilize 254 feet fall, the scheme proposed would necessitate only 7 new developments to utilize 295 feet fall. Present developments utilize an average of 15.9 feet fall each, whereas the proposed new developments would utilize an average of 42.1 feet fall per development. It is evident, therefore, that the proposed new developments will be considerably more economical per horsepower installed, both to construct and to operate, than the present developments, aside from additional advantages due to storage on the proposed new developments not available on the present developments. A condensed illustration of the present and proposed developments is shown on Plate II.

IV

RAINFALL AND STREAM FLOW

The Deep River drainage area lies in the trough of lowest rainfall in the State. Table 2 shows the mean monthly and annual rainfall at U. S. Weather Bureau stations on or near the Deep River drainage area. The rainfall at Moncure is considerably less than at any other station in the State, due to local topographic conditions. The rainfall at Fayetteville is somewhat greater than over the Deep River area as a whole.

The rainfall at Randleman appears to represent very well the average rainfall over the entire Deep River watershed. The records at this point are accurate, and for the period to 1915, when both it and the station at Ramseur were operated, the records at the two stations were quite similar. The Ramseur station has since been abandoned.

TABLE 2.—MEAN MONTHLY AND ANNUAL RAINFALL ON OR NEAR DEEP RIVER

Years of Record	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total for Year	Place
1893-1923	3.56	3.95	4.36	3.56	4.19	4.91	5.11	5.22	3.24	2.95	2.59	3.56	47.29	Greensboro
1905-1923	3.87	3.92	4.36	3.36	4.25	4.44	6.01	5.14	2.86	2.57	2.13	4.03	46.94	Randleman
1890-1914	3.35	4.09	4.20	3.48	3.68	4.26	5.17	5.46	3.70	3.05	2.79	3.79	47.02	Ramseur
1890-1914	3.47	3.86	4.11	3.43	4.28	4.34	5.31	5.24	3.75	3.03	2.50	3.15	46.47	Pittsboro
1893-1923	3.26	3.92	3.76	3.49	3.67	4.23	5.18	4.83	3.30	2.46	2.24	3.31	43.67	Moncure
1893-1923	3.38	3.95	3.79	3.23	4.21	3.06	6.43	5.73	3.69	2.85	2.48	3.28	47.71	Fayetteville

The Randleman rainfall records may, however, be safely applied to the drainage area tributary to the gaging station at Ramseur.

The monthly and annual rainfall at Randleman are given in Table 3. It will be seen that the minimum annual rainfall of 36.59 inches occurred in 1911, whereas the year of least rainfall for the general Piedmont region was 1921. The minimum monthly rainfall of 0.24 inches occurred in September, 1919, and there have been several years in which monthly rainfalls were less than those recorded in 1911 or

TABLE 3.—MONTHLY AND ANNUAL RAINFALL AT RANDLEMAN, N. C.

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total for Year
1905	3.00	5.42	1.93	3.37	11.40	1.16	7.89	7.21	1.05	1.18	.49	8.18	52.28
1906	4.82	1.97	5.49	1.27	2.37	9.20	9.64	12.53	2.09	2.91	.82	3.33	56.44
1907	.61	3.53	2.70	4.19	2.57	5.14	2.84	3.14	5.58	.71	5.09	5.08	41.18
1908	5.14	4.44	4.17	3.12	2.42	4.59	4.13	9.34	3.64	3.23	2.09	4.60	50.91
1909	1.49	3.62	3.04	1.44	6.95	7.35	4.54	7.30	1.80	2.58	.52	2.35	42.98
1910	3.77	2.87	2.51	2.44	2.81	6.21	5.89	2.81	2.03	4.90	.87	3.38	40.49
1911	2.85	2.21	3.53	3.40	2.74	2.03	1.05	5.15	2.05	4.15	3.34	4.09	36.59
1912	3.02	3.68	7.10	3.19	2.67	6.46	2.82	1.58	3.35	1.41	2.30	2.38	39.96
1913	4.71	3.62	7.69	2.55	5.44	3.77	5.47	4.51	5.33	2.20	3.75	4.64	53.68
1914	2.70	6.10	2.89	4.45	1.85	3.65	4.20	5.00	2.15	4.30	2.50	8.22	48.01
1915	5.51	3.88	2.72	1.70	6.54	4.28	4.03	10.39	3.44	4.76	1.90	3.05	52.20
1916	1.88	5.90	2.11	3.08	4.45	7.60	6.95	5.30	1.15	2.20	1.30	3.27	45.19
1917	4.70	3.97	8.71	3.05	2.90	4.45	10.32	4.39	4.21	1.93	1.20	2.30	52.13
1918	6.07	1.26	2.22	6.31	4.12	1.82	10.31	2.88	6.07	1.15	2.60	3.98	48.79
1919	5.32	3.81	2.92	2.50	6.07	2.76	9.97	3.13	.24	4.11	.52	2.03	43.38
1920	4.28	3.68	5.09	5.93	1.68	3.56	5.15	5.60	3.51	.74	4.13	6.65	50.00
1921	5.83	5.06	2.48	3.41	3.85	3.12	3.76	1.53	2.57	1.20	3.95	2.81	38.94
1922	3.86	5.84	7.32	3.31	5.93	5.15	7.54	3.24	.97	3.94	.37	3.77	51.24
1923	4.04	3.55	8.38	5.14	3.92	1.97	7.68	2.74	3.08	1.31	2.76	2.50	47.07
Average	3.87	3.92	4.36	3.36	4.25	4.44	6.01	5.14	2.86	2.57	2.13	4.03	46.93

1921. It will be noted, also, that the rainfall in the autumn months of 1923 was about as low as in the similar months of the low year, 1921. It follows from these and other considerations that extraordinary low stream flow may occur in years when the annual rainfall is considerably greater than in the minimum year. The stream flow in the fall of 1923 probably represents very nearly the minimum conditions likely to occur. The relation between monthly rainfall and run-off are shown by Table 4 and Plate VI. It is evident that no rainfall run-off formula can give the variations which actually occurred.

That rainfall, and consequently stream flow, occurs in more or less periodic high and low amounts is shown by the curve of progressive mean annual rainfall on Plate VII. It is evident from this curve that the years 1919 to 1923 have formed part of a dry period, and that the rainfall, and consequently the stream flow and water power, will probably be, on the average, greater during the next few years.

TABLE 4.—RAINFALL- RUNOFF RELATIONS RANDLEMAN- RAMSEUR

The Year 1923		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Rainfall in Inches.......	1	4.04	3.55	8.38	5.14	3.92	1.97	7.68	2.74	3.06	1.31	2.76	2.50	47.07
Runoff in Inches on Drainage Area........	2	1.67	2.03	5.18	2.14	1.05	0.58	1.53	0.516	0.54	0.209	0.36	0.63	15.69
Per Cent 2 is of 1.......		41.3	57.1	61.8	41.6	26.8	29.6	19.9	18.8	17.6	15.9	13.1	25.2	30.10

STREAM FLOW

GENERAL

A gaging station was installed on Deep River at Ramseur in November, 1922, by the United States Geological Survey in coöperation with the North Carolina Geological and Economic Survey. It was necessary to install a Gurley continuous water-stage register, due to artificial regulation of the discharge by mills above. The station has been very carefully rated. Figure 1 shows the instrument house. The station is up to date in every respect and is one of the best in the State. The records are of a high degree of accuracy.

The characteristics of stream flow for the first year of operation, December, 1922, to February, 1924, inclusive, are summarized in Table 5.

TABLE 5.—MONTHLY AVERAGE, MAXIMUM AND MINIMUM STREAM FLOW. DEEP RIVER AT RAMSEUR. DRAINAGE AREA 343 SQ. MILES

Year	Month	Discharge in Cubic-feet per Second				Run-off Depth in Inches on Drainage Area
		Maximum	Minimum	Mean	Mean Per Square Mile	
1922	December	800	51	239	0.697	0.80
1923	January	1,780	120	497	1.45	1.67
	February	2,300	145	597	1.74	1.81
	March	11,800	255	1,540	4.49	5.18
	April	2,500	150	551	1.61	1.80
	May	1,020	120	313	0.913	1.05
	June	580	80	148	0.431	0.48
	July	3,250	50	455	1.33	1.53
	August	620	54	154	0.449	0.52
	September	460	45	137	0.399	0.45
	October	84	35	62	0.181	0.209
	November	405	54	112	0.312	0.348
	December	566	75	187	0.545	0.63
The year		11,800	35	396	1.15	15.689
1924	January	2,870	140	468	1.57	1.36
	February	4,120	78	524	1.24	1.65

A hydrograph showing the stream flow at Ramseur each day for the year of record is given on Plate VI. The daily stream flow for the year has also been arranged in order of magnitude and plotted as a duration curve on Plate VIII. Curve I on Plate IX is a similar curve, but showing average weekly stream flow at Ramseur. Curves II and III, Plate IX, are based on average weekly stream flow in the average and minimum years respectively on the Cape Fear River at Fayetteville. It will be noted that Curve I is only slightly higher in the lower portion than Curve III, indicating that the stream flow at Ramseur for the past year was probably very nearly that which will occur in the minimum year. A similar conclusion was indicated by a study of monthly rainfall, as mentioned previously. The operators of power plants on the river have testified, also, that during the past year the river was about as low as it ever gets.

The stream flow for a single year does not in itself afford a satisfactory basis upon which to prognosticate, for power purposes, what may be expected on the average or in minimum years. It is very helpful in such studies to compare such a short-term record on a given stream with a record at another station on the same stream or on an adjacent stream where a long-term record is available.

Records of discharge of the Deep River were made at Moncure in 1898 and 1899 and at Cumnock in 1900, 1901, and 1902.* The records at Moncure are given in Table 6, where they are compared with records for the Haw and Cape Fear rivers for the same period. The year 1899 is the only full year of record. It was a year with run-off slightly above the average at Fayetteville. The data in Table 6 is of interest chiefly in showing (1) that the unit discharge of the Deep River is slightly greater than that of the Haw River, and (2) that the unit discharge of the Deep River is somewhat higher than that of the Cape Fear River at Fayetteville. These facts are of importance, as indicating that discharge data for the Cape Fear would give conservative values if applied on a square-mile basis to drainage areas on the Deep River. There is a record of discharge of the Cape Fear River at Fayetteville for the period 1889-1902, inclusive.*

It was intended to reëstablish the Fayetteville station on the Cape Fear and operate it in conjunction with the Ramseur station on Deep River, in order that the relation between the discharge at the two points might be discovered, and thus enable the 14-year record at Fayetteville to be applied to Deep River. After repeated attempts it was found impossible to obtain a satisfactory rating curve for the reestablished station at Fayetteville, due to conditions caused by the locks and dam at Brown's Landing, which had been constructed subsequent to 1902, when the Fayetteville observation ceased. Attempts to rate the Fayetteville station were not definitely abandoned until the

*Recorded in Bulletin 20 of the N. C. Geological and Economic Survey.

TABLE 6.—COMPARISON OF STREAM FLOW CAPE FEAR RIVER AT FAYETTEVILLE, DEEP AND HAW RIVERS AT MONCURE

Year	Month	Discharge in Cubic Feet Per Second Per Square Mile		
		Cape Fear River	Deep River	Haw River
1898	June	0.26	0.27	0.34
	July	0.62	0.58	0.53
	August	1.26	2.27	1.41
	September	0.82	1.29	1.15
	October	0.39	0.72	0.61
	November	0.66	0.81	0.83
	December	0.75	0.92	0.70
1899	January	1.14	2.05	1.58
	February	5.75	7.22	5.48
	March	3.79	5.30	4.34
	April	1.87	2.34	1.55
	May	0.82	1.26	1.05
	June	0.51	0.48	0.52
	July	0.55	0.50	0.57
	August	0.43	0.47	0.48
	September	0.25	0.29	0.26
	October	0.47	0.63	0.57
	November	0.70	0.67	0.62
	December	0.67	0.43	0.26
	Average for Year	1.41	1.80	1.44

summer of 1923. In November, 1923, a new station was established on the Cape Fear at Lillington, but it has not been in operation long enough to allow any definite conclusions to be drawn as to the present relation between discharge on the Cape Fear and Deep rivers.

The Haw and Deep rivers unite to form the Cape Fear about 60 miles above Fayetteville. Together, they contribute 70 per cent of the

drainage area of the Cape Fear at Fayetteville. The run-off characteristic of both these rivers are very similar, as they run parallel to each other for much of their length through similar country, and are of about the same size. Bearing these facts in mind, and noting further the similarity of the actual duration curves for low years at Ramseur and at Fayetteville (Curves I and III on Plate IX), it has seemed reasonable to prorate upon a square-mile basis the 14-year discharge records at Fayetteville to obtain discharge of the Deep River. As pointed out previously, this procedure will give conservative results for the Deep River, due to the fact that the unit run-off from this river is somewhat greater than that of the Cape Fear, as indicated by Table 6.

FLOOD DISCHARGE

The discharge records on the Cape Fear cover the period from 1889 to 1902, inclusive. The gage heights used in computing discharge were obtained from the U. S. Weather Bureau gage at Fayetteville. Current meter gagings to rate the station were made only from 1895 to 1902, and the maximum stage actually measured was 47.6 feet in 1901. As stated previously, recent attempts to rate this station have failed, and by plotting the measurements made during 1895-1902 it is evident that the rating was very unreliable for these years for stages in excess of 10 or 12 feet. The records of large floods, therefore, are inaccurate, and the data given in the Water Supply papers of the United States Geological Survey and in Bulletin 20 of the North Carolina Geological and Economic Survey must be used with great caution in studying flood discharge. The actual figures given for many floods are believed to be quite erroneous, and in general give too high discharge. For this reason the flood data given in these publications should not be used in Fuller's formula for flood flows, where use is made of the average annual flood actually observed.

Fortunately, the United States Weather Bureau has continued to keep gage heights at Fayetteville from 1892 to date. These observations are made each day at 8 a.m. or at the peak of a flood. Probability studies of the maximum annual gage heights for the period of record indicate that they may be used with considerable confidence to investigate the frequency of flood stages of given magnitudes. On Figure 2 there are plotted the maximum annual gage heights at Fayetteville, arranged in order of magnitude and expressed as a proportion of the mean annual maximum gage height. This data was further analyzed by probability methods,* and from it the equation of the proper probability curve was derived. This curve is plotted on Figure 2.

*Theoretical frequency curves and their application, by H. A. Foster, Proc. American Society Civil Engineers, May, 1923.

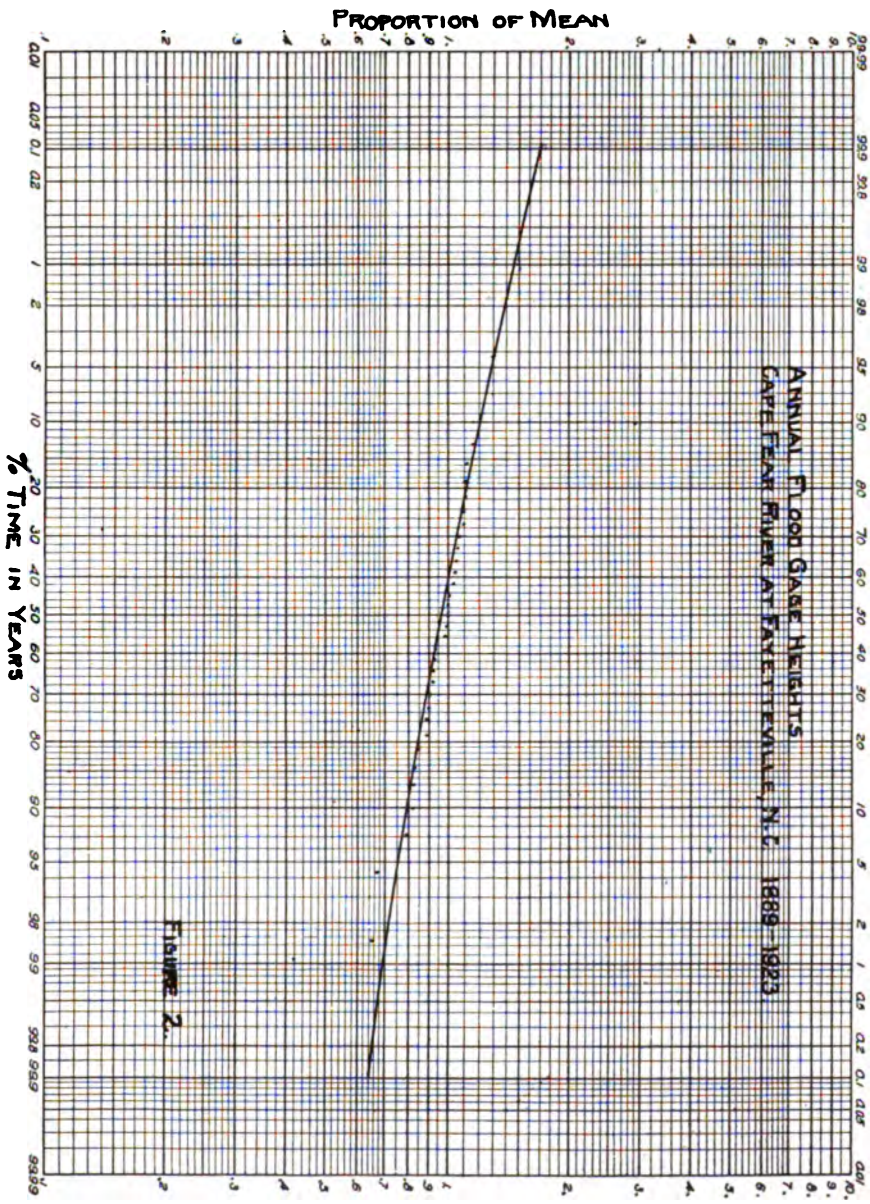

PROPORTION OF MEAN
ANNUAL FLOOD GAGE HEIGHTS
CAPE FEAR RIVER AT FAYETTEVILLE, N.C. 1889-1923
% TIME IN YEARS
FIGURE 2.

Figure 2

The maximum gage height ever recorded was 68.7 feet in August, 1908. It is apparent from the curve on Figure 2 that this stage is of much more rare occurrence than is indicated by the fact that it has occurred once in the thirty-five years of record. From the curve this stage should be expected about once in 120 years. It probably would not occur more often than once in 100 years, since a given observation is not likely to vary more than that amount from the theoretical frequency.

TABLE 6A—ESTIMATED FLOOD DISCHARGE CAPE FEAR RIVER AT FAYETTEVILLE

Number of Years in Which Flood of Given Magnitude May be Equalled or Excelled	Gage Height at Fayetteville	Discharge at Fayetteville From Rating Curve Second Feet Per Square Mile	Discharge at Fayetteville By Fuller's Formula Second Feet Per Square Mile C-54
25	59.0	14.3	21.5
50	63.5	16.1	23.9
100	67.2	17.2	26.3
200	68.4	17.6	28.8
500	73.7	19.2	32.0
1,000	76.9	20.1	34.4

TABLE 6B.—ESTIMATED FLOOD DISCHARGE ON DEEP RIVER

Drainage Area in Square Miles	Discharge in Second Feet Per Square Mile	
	500 year Flood	1000 Year Flood
100	175	250
300	130	180
500	100	110
700	75	85
1,000	50	60
1,500	45	55

Table 6a has been prepared from Figure 2, giving the number of years in which gage heights of stated magnitude may be expected to be equaled or exceeded. An attempt has also been made to evaluate these gage heights in terms of flood discharge for the Cape Fear at Fayetteville. This data is shown also in Table 6a, but is at best inaccurate, although presenting what are believed to be reasonable estimates. There is also given in Table 6a the flood flows to be expected by application of Fuller's general formula, $Q = CA\ (1 + .8 \log T)$, using the value of $C = 54$.

It should be stated, however, that Fuller derives his coefficient C from flood data which, as mentioned previously, are incorrect, and consequently the figures given by this formula are too large due to C being too great. The data given by the formula, however, are on the safe side.

The records of flood discharge on the Deep River at Moncure cover only the years 1898 and 1899. The maximum flood occurred in February, 1899, and discharged at a rate of 17.5 second feet per square mile as compared to 12.2 second feet per square mile for the same flood at Fayetteville. This was the fourth largest flood ever recorded at Fayetteville, and the ratio of the unit discharge at Moncure to that at Fayetteville is 1.44. It is believed that a factor of 2.0 is safe to apply to the unit values given in Table 6a to obtain estimates of flood discharge on the lower reaches of Deep River. Fuller's formula cannot be used directly here, unless a value of C greater than 63 is assumed. The discharge data for Deep River do not cover a sufficiently long period to enable C to be computed.

On the upper Deep River no flood measurements have been made. The present gaging station at Ramseur has a well defined rating curve up to 9 feet. This curve has been extended to 25 feet, the height reached by the 1908 flood. A flood of about 80 second feet per square mile is indicated by this extension, and the flood was probably of about that magnitude. As compared with not more than 30 second feet per square mile at Fayetteville for the same flood, the ratio is about 2.7.

From the preceding analysis of flood data, Table 6b has been prepared, giving estimates of probable flood discharges on the Deep River. It is recommended that at least the largest values given be used for design of spillways for dams.

Attempts have been made by both the State Highway Commission and the Survey to estimate flood flows on Deep River by slope and area methods from heights asserted to have been reached by the 1908 flood. The Survey has not been able to discover any results from these investigations which it feels are accurate enough to serve in any degree as a basis for estimating flood flows. A detailed study of flood flows on the Cape Fear River System will be found in Bulletin 38 of the Survey.

MINIMUM DISCHARGE

The minimum flow recorded at Fayetteville during the period of record was 0.069 second feet per square mile for a single day in September, 1900. The minimum flow recorded upon the Deep River was 0.102 second feet per square mile for one day only in October, 1923. It is improbable that the discharge of the Deep River ever gets below 0.10 second feet per square mile for more than a day or two at a time. The Cape Fear records indicate that for only about 3 per cent of the time in days will there be a daily flow of 0.12 second feet per square mile or less, and this figure has been used in calculating primary power without storage.

STORAGE

It will be apparent from the preceding paragraphs and a study of the diagrams of stream flow that the Deep River is a "flashy" stream, fluctuating between very low and quite high discharges. The stream flow each year gets quite low, much lower than is ever reached by the flow of streams in the western part of the State. The average annual and minimum monthly flows on the Deep River are respectively about 1.2 and 0.2 cubic feet per second per square mile as compared, for instance, with 2.5 and 0.5 cubic feet per second per square mile on the Hiawassee River in Cherokee County. Therefore, the primary power, or power which can be supplied constantly even in times of lowest stream flow, is very low on the Deep River. Any methods which can be utilized to increase this low-water flow are consequently of great interest to operators of present and future power developments on the river.

The best method for increasing low-water flow is by the construction of large reservoirs, in which a portion of the discharge during periods of high flow may be stored and released during low-water periods. For at least 40 per cent of the time there will be water wasting over the low power dams on the river. Some of this can well be stored if reservoirs of sufficient capacity are available. At present there are no such reservoirs on the river, and each plant gets only the normal flow of low water during dry periods. A careful study has been made to determine sites on Deep River suitable for construction of reservoirs which could be used both for power and to provide storage. The river is extraordinarily deficient in conditions favoring the location of storage reservoirs, namely, a good dam site, with large relatively flat, open areas above it. Unfortunately, the river flows for most of its length in a narrow gorge, and at only a few places do the banks provide facilities for storing much water. The only suitable locations for storage reservoirs are at Jamestown, Randleman, and Howards Mill, where dams of 40, 50, and 60 feet respectively can be constructed.

The details concerning these sites and their effect in regulating the flow of the river are given in Table 7. It will be noted that whereas the primary low-water flow of the river is about 0.12 cubic feet per second per square mile, the regulated flow available in dry seasons from these reservoirs varies from 0.45 to 0.3 cubic feet per second per square mile. The per cent cumulative increase at each storage site due to storage above is shown in the last column of Table 7. The low-water discharge and consequently the primary power at these sites is therefore increased between 275 per cent and 304 per cent.

The amount of storage available is shown in column 5 of Table 7 and is the amount of water in the reservoirs included between the crest of the dam and an elevation below the crest of about 25 per cent of the total height of the dam. Thus at Randleman the storage of 231,516,000 cubic feet is included in the top 25 per cent of the reservoir. When this amount is used up, the water in the reservoir would be 25 per cent of 50 feet or 12.5 feet below the crest of the dam. This is the storage which can be used and still operate the water wheels at the site at a reasonable efficiency. By drawing the reservoirs down below 25 per cent of the height of the dam, additional dry-weather flow may be provided. By doing this the power developed at the site would be decreased due to reduced head, but the primary power at plants below would be materially increased. This use of the reservoirs by drawing them down more than 25 per cent of the height of the dam has not been applied in any tabulated power estimates given in this report, but the advantages of this method of operation are further considered in a footnote under the discussion of "Steam Power."

Columns 6 or 7 of Table 7 show the storage required to maintain the regulated flows shown in column 9 of the same table. This data has been obtained from a mass curve or cumulative hydrograph of the Cape Fear River. This curve for the limiting low period of 1900 is shown on Plate X and has been constructed by using average weekly flows. The cumulative hydrograph for the entire period of record, 1889 to 1902, is shown on Plate XI and has been constructed by using average monthly flows.

The effect of storage in regulating the stream flow is shown by the regulated duration curves for 0.3 and 0.4 cubic feet per second per square mile on Plate IX. These curves, Nos. IV and V, should be compared with curves Nos. I and III, and indicate the effect of regulation upon the minimum flows without storage in the average and minimum years. The regulated flow duration curves have been computed from the monthly cumulative hydrograph or mass curve. It will be noted that the regulated duration curves have been computed only on the "insurance" method, i.e., on the theory that the storage reservoirs will be empty only at the end of the driest years. This is the

Table 7.—Storage and Regulated Flow Data

1	2	3	4	5	6	7	8	9	10	11	12	13
Location of Reservoir	Drainage Area in Square Miles	Height of Dam in Feet	Area of Reservoir Surface in Acres	Estimated Capacity of Reservoirs in Cubic Feet Above Draw-Down Level	Capacity Required to Give .4 Second Foot Per Square Mile in Minimum Year	Capacity Required to Give .3 Second Foot Per Square Mile in Minimum Year	Second Feet Per Square Mile Used in Computing Column 9	Minimum Regulated Discharge	Minimum Flow Without Regulation	Increase in Minimum Flow Due to Storage	Cumulative Increase in Flow With all Storage	Per Cent Increase in Flow Due to All Storage
								Cubic Feet per Second	Cubic Feet per Second	Cubic Feet per Second	Cubic Feet per Second	
Jamestown	55	40	213	185,565,600*	129,561,520	57,747,415	0.45	24.8	6.6	18.2	18.2	276
Randleman	170	50	532	231,516,000	400,462,880	178,492,010	0.3	51.0	20.8	30.2	48.4	232
Howard's Mill	572	60	2,058	1,334,141,160	1,347,439,800	600,573,116	0.4	229.0	68.6	160.4	208.8	304
Glenn's Falls	790	45	252	55,052,000	....	829,462,870	....	....	....	....	....	....

*Total volume of storage as reservoir would be empty at end of dryest year.

most conservative possible method of utilizing storage, but has been thought necessary in this case, since the annual low-water flow so frequently approaches the flow for the driest year.

SILT STUDIES

As has been mentioned previously, the filling of existing power ponds with silt has seriously affected storage of night flow, and reduced the present power available. Careful consideration has been given to methods of silt control and removal. Measurements of quantities of silt in several ponds was made, and data collected as to the rate at which silting took place. Samples of silt and sand were collected from numerous ponds. Various methods of silt removal have been considered, as follows:

(1) Pumping by floating dredge.
(2) Sluicing through openings in dams.
(3) Blasting in time of flood.
(4) Excavation by drag line scraper.

Each of the above methods has been considered from the standpoint of material to be removed and cost.

Method (1) has the advantages that it could readily excavate both sand and silt; could automatically separate sand for commercial uses; and could pump silt to farms for fertilizing purposes. The chief disadvantage is due to the difficulty which would obtain in moving the pumping unit from pond to pond. It would not be practicable to use a separate unit for each pond.

Method (2) is now used at a number of ponds, but is open to two objections. The existing gates can only be operated in low-water periods when sluicing is least effective, and these gates are so small that the effect of sluicing through them is not felt to any considerable extent in the pond. As new developments are constructed, provision should be made in the dams for large gates which may be operated from the power house in time of flood. These gates should be large enough to pass a considerable portion of the flood flow; they should be placed with due regard to the direction of the current; and they should be placed high enough not to be interfered with by back-water. Gates in dams constructed with these conditions in mind have successfully controlled silting in this State and elsewhere.

Method (3) has been taken up with the powder manufacturers. The consensus of opinion is that it would prove more expensive than the other alternative methods.

The use of movable drag-line excavators (method 4) appears to be the cheapest and most feasible method for silt removal in existing ponds. One such excavator of about one and one-half cubic yards capacity can be readily moved from pond to pond as conditions re-

(a) Removing silt from pond, Worthville

(b) Removing silt from trash racks, Worthville

FIGURE 3

quire. In most cases the banks are such that an excavator can work from them economically. In several places sand of good quality may be removed, and there is a ready local market for it. This would in part pay for the cost of excavation. The value of the increased pondage is easily worth the remaining cost of operation. It is estimated that on the basis of present installations at least 20,000 h. p. hours are lost daily for 150 days annually due to inability to store night flow. At as low a cost as one-half cent per h. p. hour this amounts to $15,000 per year. The annual cost of operating the scraper would not amount to nearly this sum when averaged over several years. If the scheme of river control recommended later is adopted in principle, the removal of silt from various power ponds would be undertaken by the authority controlling operation of the power system, and a new study of the relative costs of the methods of silt removal might indicate that method 4 was not then the most economical.

An important advantage in the high storage dams mentioned in the previous section will be their effect upon silting, as follows:

(1) They are strategically located to intercept silt and sand. They are large enough so that there will be a rather definite separation of sand from silt. The sand will be deposited in shallow water at the head of the ponds, where it can readily be removed and sold. The silt will be carried toward the deeper portion nearer the dams.

(2) The space for accumulation of silt is large, amounting to at least one-half the height of the dams, before the utilizable water storage volume is reached.

(3) Large gates, operated by electric power, can be placed on the dams, so that if silt accumulates it can be flushed out when the river is in flood, if this is desired.

(4) There appears to be a tendency in reservoirs of a certain size, and bearing a given relation to the size of a stream, to keep flushed out above a given level. It happens often that such a reservoir will fill to two-thirds the height of the dam with silt, but the decreased cross-section resulting from this makes floods scour out the upper third, which is all that is used for storage of water. It is believed, from observations on existing reservoirs on the Deep and Catawba rivers, that there is a probability that no serious loss of storage capacity through silting will occur in the proposed reservoirs.

(5) Most of the deposits now carried by the river come from above Coleridge. It is probable that the proposed reservoirs at Jamestown and Randleman will (1) trap most of the deposits now going down the river; (2) enable commercial sand to be recovered; and (3) enable silt to be removed at one or two places economically instead of at ten or twelve places at considerable expense. Therefore, by building these reservoirs, the shallow ponds below would probably not be troubled

again to anything like the present extent, once they had the silt removed, and consequently would be able to store the night flow.

It is probable that the power companies may later find it economical to adopt erosion control methods to prevent or lessen the silt and sand now being carried by the stream. On the headwaters, especially above Randleman, a forestation policy combined with inexpensive erosion control devices would undoubtedly serve to materially lessen the very large amounts of sediment now carried by the river with resulting destruction of agricultural land. It is believed that such a policy would not prove unduly expensive, and it should be considered by any company proposing to carry out the scheme of unit development of the river.

V

WATER-POWER INVESTIGATIONS

PRESENT WATER-POWER INSTALLATIONS

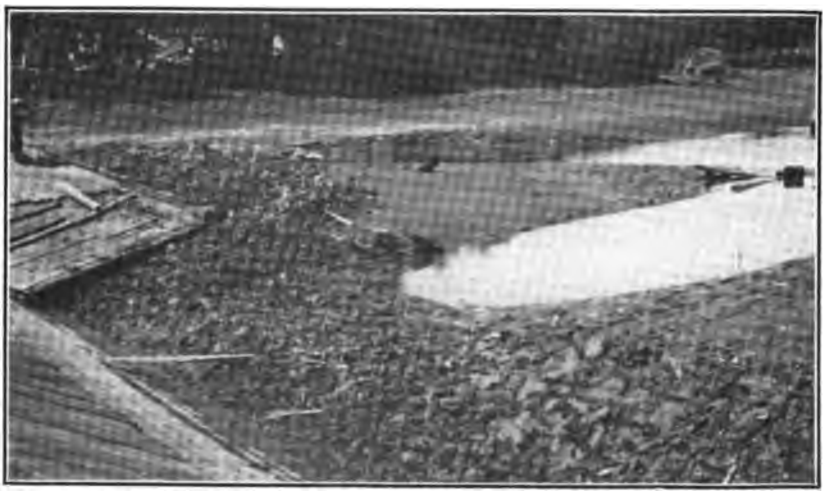
Details as to 16 present power developments on the river are given in Table 8. It has not been regarded as economically practicable to flood out any of these developments by new dams. The present installations are entirely separate in ownership and in operation. None are interconnected for the transfer of power except that the Deep River Power Company connects from Lockville to Ramseur and Franklinville.

Essentially, under the present scheme of development, each plant operates as an entity, and takes whatever water comes to it from developments upstream. As indicated in Table 10, this is an exceedingly uneconomic arrangement, since the plants get only the "run-of-the-river," and in many instances can not even store the 14-hour night flow due to silting of the ponds.

The primary 24-hour power is extremely small, and is shown in column 6 of Table 8. The wheel capacity installed at the various developments is greatly in excess of this amount, and is shown in column 5 of Table 10. It is apparent that each year during the low-water season the water-power plants have to operate on part time or shut down entirely. As a consequence each mill has to have an auxiliary steam plant to help meet its power demands in dry periods. In general, these steam plants are equal in capacity to the water-power plants. They are small, are usually inefficient, and relatively expensive to operate.

Column 10 of Table 8 indicates of what great value the proposed new storage developments would be to the present installations on the river. It is shown by comparing the totals in columns 6 and 10 and columns 7 and 11, that the primary 24-hour and 10-hour power at *existing developments* would be increased by 1,719 h. p. and 4,114 h. p. respectively.

(a) Removing silt from head race, Randleman



(b) Silt Deposit, Randleman

FIGURE 4

RECOMMENDED NEW DEVELOPMENTS ON DEEP RIVER

In the course of the river survey, every feasible dam site was carefully investigated. The sites finally decided upon represent those best adapted for a comprehensive development of the entire river. The sites selected in every instance, except at Jamestown, are suitable for the economical construction of masonry dams, having narrow cross-sections with good rock foundations and abutments. The sites are discussed in detail below. The location is shown on the general map, Plate I, and on the map and profile Plate II. Cross-sections of the proposed dam sites are shown on Plate XII.

JAMESTOWN. This site is located just below the forks above the highway bridge over Deep River west of Jamestown. It is the first practicable dam site on the river. A 40-foot dam could be built here. The section is rather wide, but rock abutments are possible. An earthen dam would probably be the most satisfactory and cheapest, since it would hardly be profitable to utilize power at this site. As contemplated, the reservoir formed by this dam would be used chiefly to increase the low-water flow of the river below. It will increase the primary 10-hour horsepower at Oakdale Cotton Mills, 3 miles below, to 173 h. p., whereas at present it is only 55 h. p. This, however, is the least of the benefits. The increased low-water flow due to Jamestown storage, from column 11, Table 7, is 18.2 cubic feet per second. This will be effective over the 254 feet fall now developed and produce 420 additional primary 24-hour h. p. It would produce 450 additional primary 24-hour h. p. at the proposed new developments below, or a total of 870 additional primary 24-hour h. p. if the river is fully developed. One hundred twenty-five dollars per h. p. is a very reasonable amount to pay for installed primary power. The cost of constructing the Jamestown reservoir, including purchase of land, should not exceed $110,000. This development would flood out the small Jamestown Roller Mill on the West Fork of the river. This reservoir may also be used in connection with a steam station, as mentioned later in the section on "Steam Power." The figures of horsepower above should be multiplied by 2.4 if 10-hour use is made of the flow.

RANDLEMAN. A site exists here, a short distance above the present dam of the Deep River Cotton Mills, where a dam 50 feet high may be constructed to provide good storage and power. The details as to storage are given in Table 7 and as to power in Table 9. The reservoir would be about nine miles long. The present two developments at Randleman utilize 24 feet fall, and produce some 106 primary, 10-hour h. p. This would be increased to 622 h. p. with the 50-foot dam at Randleman and to 840 h. p. with both Randleman and Jamestown storage. The secondary power at Randleman would also be increased materially, due to the extra height of the dam. At present

TABLE 8.—EFFECT OF UPSTREAM DEVELOPMENTS UPON EXISTING PLANTS ON DEEP RIVER

1	2	3	4	5	6	7	8	9	10	11	12	13
Company	Location	Drainage Area in Square Miles	Fall Now Developed	H. P. Now Installed	Primary H. P.		Present Secondary	Present Total	With Upstream Storage Primary H. P.		With Upstream Storage 24-Hour 7 Months Average Year	
					24-Hour	10-Hour	7 Months	7 Months	24-Hour	10-Hour	Secondary	Total
Oakdale Cotton Mills	Oakdale	69	30	575	23	55	107	130	72	173	36	108
Chilton Mills	Chilton	92	8	25	8	19	38	46	21	50	9	30
Deep River Mills No. 1	Randleman	170	12	256	22	53	106	128	Replaced ment. See	by New Table 9.	Develop-	
Deep River Mills No. 2	Randleman	170	12	256	22	53	106	128	56* 75	134* 180	39	114
Leward Cotton Mills	Worthville	223	18	400	44	106	209	253	94* 124	225* 297	119	243
Central Falls Mills No. 1	Central Falls	243	8	200	22	53	100	122	43* 57	103* 137	56	113
Central Falls Mills No. 2	Central Falls	245	22		59	142	281	340	120* 156	288* 374	137	313
Sapona Cotton Mills No. 1	Cedar Falls	257	24	150	67	161	322	389	134* 174	321* 418	186	360
Sapona Cotton Mills No. 2	Cedar Falls	260	9	50	26	62	121	147	51* 65	122* 156	72	137
Randolph Mills No. 1	Franklinville	276	18	345	54	129	259	313	104* 134	250* 321	158	292

Randolph Mills No. 2	Franklinville	276	10	180	30	72	144	174	58* 74	139* 178	88	162
Columbia Mfg. Co.	Ramseur	342	13	480	49	118	231	280	85* 106	208* 255	160	266
Enterprise Mfg. Co.	Coleridge	391	17	520	73	175	347	420	120* 148	287* 355	252	400
High Falls Mfg. Co.	High Falls	748	20	250	163	390	779	942	454† 544	1,090† 1,305	301	845
Sandhill Power Co.	Carbonton	970	14	1,000	148	355	255	855	352† 414	845† 994	374	788
Moncure Mfg. Co.	Lockville	1,340	19	1,100	277	665	855	1,615	555† 638	1,333† 1,532	872	1,510
SEE FOOTNOTE. Totals		1,340	254	5,787	1,087	2,611	4,360	6,285	2,319† 2,806	5,568† 6,725	2,879	5,681

Jamestown Roller Mill	20	20
Coltrane Mill	8	30
Walkers Mill	8.6	0
Howards Mill	12	30
Grand total	312.6	5867

NOTE: These totals include only those existing developments not flooded out by proposed new developments. The Grand total includes four small mills which would be flooded out.

To obtain 10-hour, power with pondage, multiply 24-hour power by 2.4.

Secondary power is that power in excess of primary power and available for 60% of the time.

This assumes that pondage is available to store 14-hour night flow. This cannot be done at present at most plants.

*Upper figures indicate power with Randleman storage only. Lower figures indicate power with all storage.

†Upper figures indicate power with Howard's Mill storage only. Lower figures indicate power with all storage.

about 614 10-hour h. p. is available for 60 per cent of the time at the two developments. With the 50-foot development this would be increased to 1,415 10-hour h. p. The effect of the increased primary flow on present downstream developments would be to add 560 primary 24-hour h. p. or 1,345 primary 10-hour h. p. This development would flood out Walkers and Coltrane Mills. The first is now owned by the mills at Randleman and was purchased so that it could be flooded. The last has not been operated for some years, and the dam is destroyed.

SITE No. 1. This is located at the head of the present upper Franklinville pond. A development of 20 feet here will back water to the tail-race of the Cedar Falls development. No storage is available. The amounts of power that can be developed are shown in Table 9.

SITE No. 2. This is located at the head of the present pond at Coleridge. A development of 20 feet here will back water to the tail-race of the Ramseur development. No storage is available. The amounts of power that can be developed are shown in Table 9.

HOWARDS MILL. This site is the key to the economic development of the entire river. The highest dam can be built here. The best dam site is located here, and the greatest amount of storage on the river exists above this site. A 60-foot dam here will back water to the tail-race of the development at Coleridge. The reservoir surface would cover 2,050 acres or more than three square miles, and would extend for about ten miles above the dam. It would be the largest body of water in the Piedmont District of the State, and would probably become a location for resort developments. This development would flood out the present 8-foot fall at Howards Mill.

The primary power at this site would be 1,070 24-hour h. p. or 2,570 10-hour h. p. without use of storage at either Randleman or Jamestown. With these projects operating, the primary power at Howards Mill would be 1,390 24-hour h. p. or 3,340 10-hour h. p. This single development would provide more primary power than now exists on the entire river. It would increase the primary power at present developments by 774 24-hour or 1,858 10-hour h. p. If the developments below at Glenn's Falls and Gurley dam site are constructed, this one project at Howards Mill will add 1,871 24-hour or 4,500 10-hour primary h. p.

GLENNS FALLS. This is a very good site, at which a dam 45 feet high can be constructed, backing water to the tail-race at High Falls. Although the height of dam is considerable, the river flows for most of the distance in a narrow gorge. The storage, with a 25 per cent drawdown, is indicated in Table 7, and is seen not to be sufficient to afford any appreciable regulation. It will, however, afford ample pondage for 10-hour operation. The amounts of power which can be developed are

TABLE 9.—ESTIMATED POTENTIAL UNDEVELOPED WATER POWERS ON DEEP RIVER

1	2	3	4	5	6	7	8	9	10	11
Location	Drainage Area in Square Miles	Fall in Feet	Primary Horse Power				Total H. P. 60% Time 24-Hour		Secondary H.P. 60% Time 24-Hour	
			Without Storage		With Storage		Without Storage	With Storage	Without Storage	With All Storage
			24-Hour	10-Hour	24-Hour	10-Hour				
Jamestown	55	40	Held for	Storage.	No Prim	ary Power	139	109	----------	----------
Randleman	170	50	93	223	203† 275	488† 660	536	476	443	201
Site No. 1	276	20	60	144	116† 149	278† 358	348	324	288	175
Site No. 2	381	20	83	199	138† 172	331† 412	480	456	397	284
Howard's Mill	572	60	373	896	1,070* 1,390	2,570* 3,340	2,160	1,870	1,787	480
Ritter's Dam Site	580	30	189	454	628* 816	1,506* 1,958	1,100	739	911	121
Glenn's Falls	790	45	388	930	1,045* 1,230	2,510* 2,850	2,240	2,015	1,852	785
Gurley Dam Site	1,339	30	438	1,052	877* 1,064	2,102* 2,550	2,530	2,380	2,092	1,316
Totals	1,339	295	1,624	3,898	4,077 5,096	9,785 12,128	9,533	8,567	7,770	3,362

To obtain 10-hour power with pondage, multiply 24-hour by 2.4

Secondary power, is that power in excess of primary power, and available for 60% of the time.

†Upper figures indicate power with Randleman storage only, lower figures indicate power with all storage.

*Upper figures indicate power with Howard's Mill storage only, lower figures indicate power with all storage

shown in Table 9. The floor of the highway bridge over the river at Glendon is about 6 feet above the crest of a 45 foot dam at Glenns Falls.

HURLEY DAM SITE. This is located at the head of the present pond at Lockville. Conditions as to pondage are very favorable. There may be even some slight regulation for periods of a week or more in times of low flow. The estimates of power are given in Table 9.

POWER ON TRIBUTARIES OF DEEP RIVER

ROCKY RIVER. This is the only tributary of Deep River of any importance from a power standpoint. There is a small development on this stream near Siler City, but the drainage area above it is insufficient to contribute much water, and its use has now been abandoned for service to Siler City. The Rocky River Power Company has developed a site near the point where Bear Creek flows into Rocky River. There is at present 240 h. p. installed. A transmission line connects this development with the system of the Sandhill Power Company. It is intended soon to divert Bear Creek into Rocky River above the power house, and to then install 320 h. p. additional. The same company controls a site about three miles above the mouth of Rocky River. This site can be developed for about 30 feet head and will flood to tail-water of the present development. The status of Rocky River power development is indicated in Table 10. The developments outlined are already planned to be built, and will be interconnected with the Deep River system.

TABLE 10.—WATER POWER ON ROCKY RIVER

1	2	3	4	5	6	7	8
Location	Drainage Area in Square Miles	Fall in Feet	Horse Power Installed	Primary Horse Power		Secondary H. P. 60% of Time	
				24-Hour	10-Hour	24-Hour	10-Hour
Near Bear Creek	187	25	240	60	144	297	714
Bear Creek Diversion	52	25	320*	30†	72†	83†	200†
3 Miles Above Mouth	253	30		172	412	415	1,000
Totals	253	55		262	628	795	1,914

*Planned to install at present development.
†Additional to present power.

CABIN CREEK. There are a few sites on this stream capable of development for small powers, ranging from 100 to 200 h. p. Although this stream is of some size (drainage area about 150 square miles), and has a good flow from the sandy region it drains, it is believed that it is not practicable to interconnect any powers that might be developed with the Deep River system.

OTHER SITES. All of the tributaries of Deep River have been investigated, and also in Moore County reconnaissance has been made of McClennons and Drowning creeks and Little River. No undeveloped sites regarded as susceptible of economic development were found. A cross-section of a fair site on Drowning Creek is shown on Plate XI. It is not regarded that this site can be developed for hydro-electric purposes in an economic manner. This site could be developed for a roller mill or such small local use. It is not the function of this report to consider those projects which could not be properly connected into the scheme for development of the Deep River as a unit.

SUMMARY OF WATER-POWER DEVELOPMENTS

Table 11 summarizes the possibilities of hydro-electric development on Deep and Rocky rivers. It is desired to point out the contrast between what is now developed on these streams and what they are capable of producing. At present 279 feet fall is developed on both rivers, with the production of 1,147 24-hour or 2,755 10-hour primary horsepower and 4,597 24-hour or 11,030 10-hour secondary horsepower theoretically available. Actually, the 10-hour powers given are not available, because many of the present power ponds are so silted as to preclude storage of night flow.

In contrast with the statements above, if the rivers are fully developed for 604 feet total fall there can be produced 8,164 24-hour or 19,500 10-hour primary horsepower, an increase of 7,017 primary 24-hour h. p. equivalent to an addition of 610 per cent to the present primary power. There can also be produced 6,774 24-hour or 16,374 10-hour secondary power for about seven months. As stated above, the 10-hour power given can not be realized unless the silt is removed from several present ponds. Much of the secondary power can be converted into primary power by steam auxiliary as described in the next section.

The storage provided in new reservoirs will afford considerable protection from floods, and will add about 400 primary 24-hour horsepower to the present development at Buckhorn Falls on the Cape Fear, an increase in developed power not mentioned in the tables, but adding to the power production of the State.

TABLE 11.—SUMMARY OF WATER POWER SITUATION ON DEEP AND ROCKY RIVERS

1	2	3	4	5	6	7	8	9	10	11
	Fall Developed in Feet	Present H. P. Installed	Present Primary Horse Power		Primary H. P. With All Developments		Secondary H. P. 60% of Time† at Present		Secondary H. P. 60% of Time With All Developments	
			24-Hour	10-Hour	24-Hour	10-Hour	24-Hour	10-Hour	24-Hour	10-Hour
Present Water Power Installations*......	254	5,787	1,087	2,611	2,806	6,730	4,360	10,460	2,879	6,920
Proposed Water Power Installations.....	295				5,096	12,230			3,362	8,068
Total for Deep River........	549	5,787	1,087	2,611	7,902	18,960	4,360	10,460	6,241	14,988
Rocky River. Present and Proposed...	55	240	60	144	262	528	237	570	533	1,386
Grand Total............	604	6,027	1,147	2,755	8,164	19,488	4,597	11,030	6,774	16,374

*Includes only those present installations not flooded out by proposed new developments.

†Secondary power is defined as that power in excess of the primary power and available 60% of the time in the average year.

VI

STEAM POWER AUXILIARY

To develop any such "flashy" stream as Deep River to its maximum economic capacity involves the use of steam power to supplement the water power during periods of deficient flow. This is true even though considerable regulation by storage is possible, since it is very rarely indeed that there is sufficient storage available to utilize even 70 or 60 per cent of the total annual flow. Tables 8 and 9 indicate what the river is capable of producing with and without storage. These two tables are summarized in Table 11. It is evident that present installations are far in excess of primary power available. Consequently, if mills are run during low-water season, steam auxiliary is necessary. Nearly every mill has a steam plant for this purpose, and in several instances the plant runs entirely on steam in dry seasons.

Table 11 shows that with the Deep and Rocky rivers fully developed there will be available for seven months of the average year about 6,774 24-hour or 16,374 10-hour h. p. over and above the 8,164 primary 24-hour power.* To utilize this for industries or public utility service which requires all-the-year power, steam auxiliary of the same amount would be needed. In other words, to develop the river to supply a constant demand of about 15,000 24-hour or 26,500 10-hour h. p. will require steam capacity of only 6,774 or 16,374 h. p. respectively. This steam capacity would, moreover, have to be utilized only about one-third of the time. It is entirely probable that when the load relations are studied, less steam capacity could be installed, peak loads being taken by the water-power plants.

There is at present installed on the river, and available for connection into any scheme of river development, the steam power indicated in Table 12. The plant capacities given are over and above the installed capacity required for plant process steam.

TABLE 12

Oakdale	200 h. p.
Randleman	600 h. p.
Cedar Falls	200 h. p.
Franklinville	200 h. p.
Ramseur	200 h. p.
Gulf	2,000 h. p.
Total	3,400 h. p.

*This assumes that storage is utilized on the "insurance method" and that reservoirs are not drawn down below 25 per cent of their depth. In actual operation, after a few years experience, it would become possible to utilize this storage at greater rates than by the rather inefficient insurance method, and also it would be possible to utilize storage at Randleman and Howards Mill below the 25 per cent level in very dry periods. Thus by shutting down the Randleman power plant and drawing down the Randleman reservoir, 17 second feet additional could be delivered over some 400 feet fall equivalent to 618 primary horsepower, less the loss of 230 horsepower at Randleman, or a net gain of some 380 horsepower. This sort of operation of the reservoirs can not be forecast, but must be based upon operating experience. It is mentioned here merely to indicate that the figures as to primary power utilized in the report, and based upon the "insurance method" of utilizing storage, may be exceeded in practice.

All of the plants except those at Randleman and Gulf are small and rather inefficient. On the other hand, they may, to some extent, be also utilized in making process steam, and thus reduce the charge for power. The plants at Gulf and Randleman, which are on opposite ends of the river, are efficient and should be an important link on any system of connecting up the plants by transmission lines. The present plant at Gulf is of 2,000 h. p. capacity, but at least one-half of this is utilized in supplying the lines of the Sandhill Power Company to the south, and is not available for local Deep River use. This plant, however, is very modern and is planned so as to be easily doubled in capacity. If that were done, there would be on the river about 5,400 installed h.p. in steam units available for interconnection. That is, by the addition of the contemplated 2,000 h. p. steam station at Gulf no more steam auxiliary would be necessary to fully develop the river for 13,560 h. p. 24 hours in the day, available in the driest periods. Similarly 24,900 primary 10-hour power could be delivered.

Even with the present steam plants of 3,400 h. p. available, the river could be developed for 11,560 24-hour or 22,900 10-hour h. p. available in the driest periods, and have to use steam power only about one-third of the time. Since the requirements for some time to come are not likely to reach any such figure as 10,000 24-hour h. p., it is manifestly unwise to go on building steam plants if the river can be made to do the work economically without them. It should be pointed out that the figures as to power given above indicate what the combination of water and steam power can produce. The actual power to install would differ from this by taking into account the load factor.

RELATION OF DEEP RIVER COAL FIELDS

The development of the river for maximum power as outlined above is greatly facilitated by the location of the coal fields near Cumnock. Here mouth-of-the-mine steam plants may be located near good condensing water. The new steam station of the Sandhill Power Company at Gulf has been the first to make use of this fortunate circumstance. Steam power can be produced here with great economy. Future steam plants may best be built here, at least until the river is pretty completely developed. The location of the coal-bearing areas is shown on Plate I.*

In the event the development of the river continues along the lines set forth in this report, it may be desirable to locate a steam plant at the upper end of the system. A steam station of 1,500 h. p. to 2,000 h. p. could be built below the Jamestown reservoir and have sufficient condensing water delivered to it by gravity to enable it to operate efficiently.

*"The Deep River Coal Field of North Carolina," Bulletin 33 of the N. C. Geological and Economic Survey, describes the coal in detail. Some 68,000,000 tons of excellent coking and by-product coal are reported.

VII

PLAN FOR DEVELOPMENT

GENERAL SCHEME

There has been outlined a plan whereby the Deep River can be completely developed by a combination of hydro-electric and steam-electric power plants to provide some 15,000 continuous 24-hour power or about 26,500 continuous 10-hour power. The actual amount of horsepower to install would depend upon the character of the load and would probably lie somewhere between these figures. In addition, secondary power would be available for about one-third of the time.

This 15,000 continuous 24-hour power is made up of (1) 1,147 h. p. primary water power and 3,400 h. p. steam power at existing developments; (2) 1,715 h. p. added to existing developments by virtue of increased flow due to storage; (3) 5,296 primary h. p. at 7 new hydro developments; (4) 3,442 h. p. at new steam stations. It is especially desired to point out that the new developments will, by virtue of increasing the flow, more than double the present primary water power at existing plants, and will in addition contribute about 5,300 primary water power by themselves, making a total addition to the *primary* water power on the river, of about 7,000 h. p. This alone will serve the normal growth in primary power demands for some time, without the construction of additional steam plants.

Much of the additional power will be, and is now, required by existing mill and industrial developments. Moreover, as new developments come into the region, attracted by availability of cheap power, they will not necessarily wish to locate at power sites. On the contrary, the tendency of manufacturing plants, particularly cotton mills, is to locate where labor is plentiful, where raw materials are near, and where transportation facilities are good. Then there must be brought to them cheap power.

To effect a proper distribution of the additional power which can be developed on Deep River so that it can be transmitted to existing and new industrial enterprises in the region necessitates a local superpower system. All present and new water-power and steam plants would be interconnected by transmission lines, and would feed into these lines. All present mills and new industries would take their power from these lines. In this way, and in this way only, can the river be fully developed in an economical manner, so that the power it produces can be delivered wherever it is needed, whenever it is needed, and in whatever quantity it is needed.

TRANSMISSION LINES

Fortunately, the major parts of the necessary transmission lines to effect interconnection of plants and industries have already been constructed. Both the existing and recommended transmission lines are shown on the map on Plate I.

The power line of the Deep River Power Company already comes to Ramseur and Franklinville, starting from the power house at Lockville. At Siler City this line may be readily interconnected with that of the Sandhill Power Company, which comes from the hydro-electric plant at Carbonton and the steam plant at Gulf. The capacity of the line from Lockville to Ramseur is 3,000 h. p. at the present voltage of 38,100 volts. The line from Carbonton to Siler City can be easily raised to the same voltage by placing new transformers at Carbonton, or if the existing transformers can be connected to give 22,000 volts, they can then be connected to give 38,100 volts. The Sandhill Power Company lines may then connect at Siler City with the Deep River Power Company's lines to Ramseur. To do this, the spacing of the wires on the Sandhill Power Company line would have to be increased; but this is not an expensive or difficult undertaking. The suggestion is made that the Sandhill Power Company's lines be increased in voltage rather than that the voltage on the Deep River Power Company's line be decreased, because more power may be carried at the higher voltage over the same wires.

To make the power from Lockville, Carbonton, and the Gulf steam station effective immediately along the river above Ramseur only about 12 miles of transmission line from Franklinville to Randleman need be constructed. From Ramseur a low-voltage line of 6 miles would connect Coleridge. To interconnect the proposed new developments at Howards Mill, Ritters Falls, Glenns Falls, and Moncure would only require 15 miles of new line and would bring on to the system some 4,500 primary 24-hour h. p. Later, for purposes of regulation it would be desirable to carry the lines from Liberty to Randleman and from Gulf to Moncure, a total distance of only 25 miles.

By building only 33 miles of transmission line, with changes to existing lines noted, there would be provided immediately means for interconnecting all the present and projected power developments on the river. It is the opinion of the Survey that since the projected developments are at sites which can be economically developed, the interests along the river would be very unwise to look elsewhere for their needed increase in power. The system described by means of Tables 8 and 9, with Plates I and II, would be entirely self-contained. The voltage used would be sufficiently low, due to the relatively short distances, to make transformer stations much cheaper than from higher voltage lines. The control of the power would presumably be entirely in the hands

Transmission line, Ramseur

Franklinville Transformer

Sandhill Power Co., mouth of mine steam plant, Gulf, N. C.

FIGURE 5

of the present interests along the river, who would be then independent of the general tendency to increased power rates on the larger systems due to the growing demand for power, which the larger companies have to meet by increasingly expensive developments and long transmission distances entailing considerable power losses.

METHODS FOR EFFECTING DEVELOPMENT AND OPERATION

At present there are on the river 17 water-power developments, of which all but two are individual mill developments. There is no provision at any of the 17 developments for transmitting power to any other development except that the plants at Ramseur, Franklinville, and Lockville are interconnected. With the existing highly individual state of development on the river it will be practically impossible to develop the river as a unit to obtain the maximum amounts of power described in this report. To obtain this power the river must be developed and operated with a view to the benefits accruing to *all* the interests on it from *each* development.

To effect the development of the river in the best way and to obtain the most power in the most economical manner, two plans are necessary and are described below:

(1) PLAN OF CONSTRUCTION. The new developments on the river should be made in proper order, with due regard to their cost, to the power they will produce, and to their effect upon other developments. It is suggested that the Howards Mill development be one of the first undertaken. It will be relatively cheap to construct; it will produce a large amount of primary power; and from its large storage it will have a very beneficial effect upon existing installations below. It will add 204 24-hour h. p. at Carbonton and 278 24-hour h. p. at Moncure during low-water periods. Probably the proposed developments at Randleman and Gurley Dam Site would be next in order. Of course, local conditions, such as difficulty in acquiring sites, distribution of load, etc., may affect the order of construction, as well as the factors outlined above. The chief point is to have the developments made in accordance with a well devised scheme and with due reference to benefit to the river interests as a whole.

(2) PLAN OF OPERATION. As the new developments are made and all of the installations on the river interconnected by transmission lines, the utmost power will only be obtained if all power plants are operated as a part of one system. By the scheme outlined, all power plants will feed into the system, and industries will take their power from the lines, not knowing or caring where it is produced. An efficient method of operating the system is fundamental, in order that power in ample quantity may be available wherever and whenever it is desired. To effect this, the entire power generating system should be under the con-

trol of one organization, whose sole duty would be to provide power service efficiently and get the most out of the river at the least cost.

The importance of proper technical supervision over construction and operation cannot be too much emphasized. The choice of proper materials for transmission lines, the selection of efficient machinery for new installations, the adequate inspection of construction to insure economical and safe structures, and the order of constructing new projects, are all matters requiring a high degree of engineering judgment. The operation of all plants to get the maximum use from the water, the most economical methods of utilizing steam plants, the choice of new machinery in existing developments to obtain greater efficiency, the choice and distribution of load to render operation more economical, are only a few of the operating problems requiring expert knowledge. Many of the developments now on the river are losing money every day because adequate technical advice on the subjects noted above was not secured. The best results in developing Deep River for its maximum power possibilities will be obtained by the employment of a single well paid engineering executive to carry out the entire scheme of development, whether or not the plan ultimately agreed upon carries out in every detail the suggestions contained in this report.

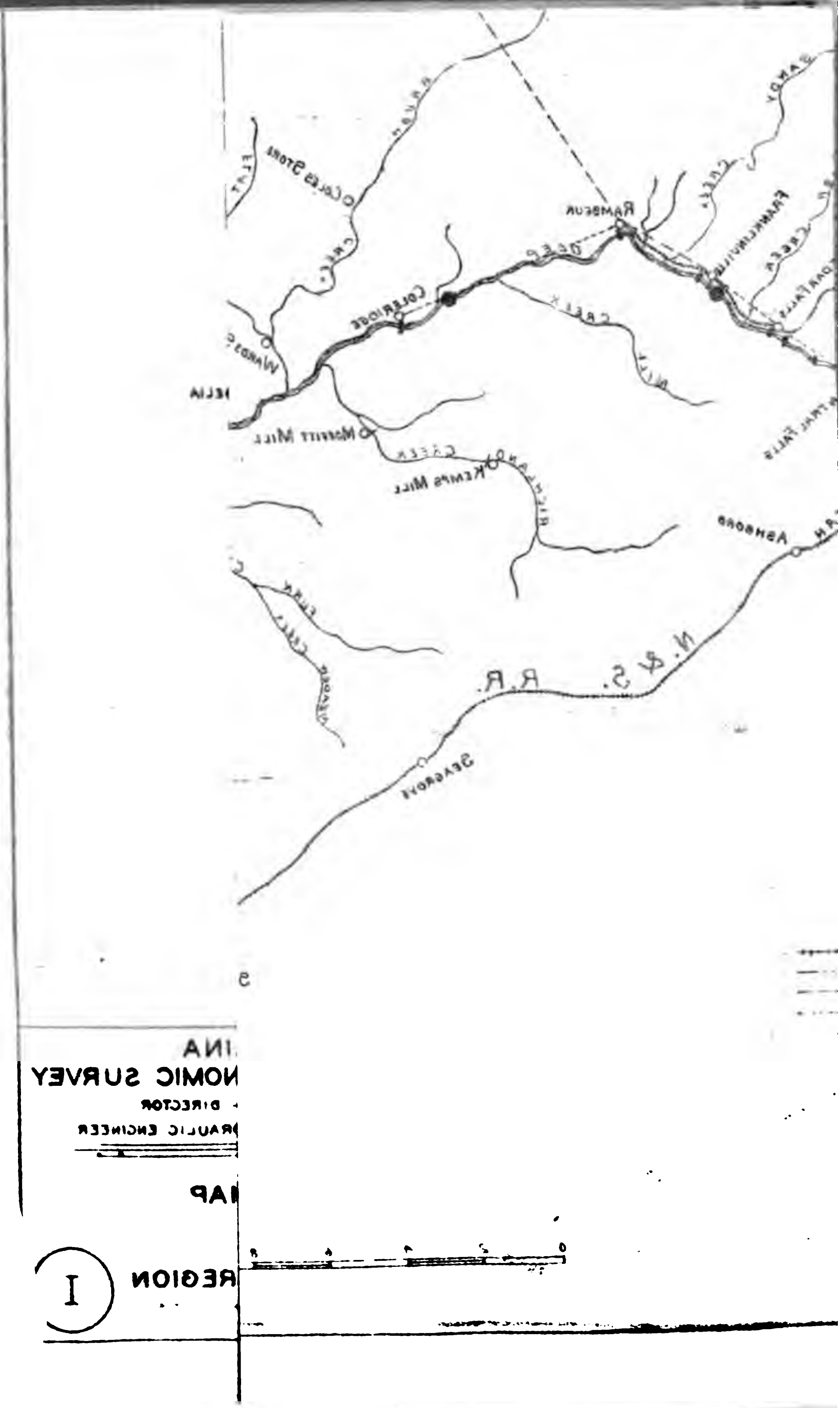
SUGGESTED PROCEDURE

To most efficiently carry out the plan of construction and the plan of operation, some concerted action by the various interests along the river is necessary. Not only is this desirable from the standpoint of the two plans, but probably no single interest would desire to finance more than one of the proposed developments.

It is suggested that the various interests along the river combine to form a holding company, based perhaps on some merger of the Sandhill and Deep River Power companies. The mill interests would presumably control stock in the holding company, which would be operated to control all the power on the river. All plants, both present mill and hydro-electric plants and projected developments, would feed into the transmission system. All mills would be fed from the system. When mills wished power, the power company would be requested to furnish them the amount specified in contracts and under terms which the mills had with the power company. This company they would essentially control through stock, or by their directors elected to the board of directors of the company, or both. The mills would then be assured of power when they needed it and in whatever quantity they wished, without having to bother about where it was generated. The power company would control the river as a unit for power purposes. It would employ expert technical service and be operated in the most efficient manner.

This scheme is outlined merely as a suggestion. There will no doubt be other possible and better methods of effecting the end sought. The Survey only desires to emphasize the major point in the proposal, namely, that the development of the maximum amount of power by the river is necessarily predicated upon some sort of control which will enable the entire stream to be developed and operated as a whole. This method is, of course, in general use by large power companies, and the control by mill and allied interests is in use at Roanoke Rapids in this State, and at Merrimac, Lowell, Holyoke, and other places in the North. The suggestions contained herein are therefore not novel or untried, but have worked efficiently and satisfactorily elsewhere. By their adoption in principle the Deep River may be made to provide the power demands for industries in its vicinity for a very long time in the future, and probably at considerably less cost than a similar amount of power could be obtained by any other means.

In connection with the suggestions made above concerning the developments on the Deep River, it is proper to point out that the logical extension of the scheme would include a similar study and development of the Haw River. The two systems would then be presumably interconnected and both together operated as a unit. It is probable that fully as much undeveloped power exists on the Haw as on the Deep River.


Coles Store
Coleridge
Ramseur
Deep
Creek
Franklinville
Moffitt Mill
Kemps Mill
Richland
Ashboro
N. & S. R.R.
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DIRECTOR
RAULIC ENGINEER
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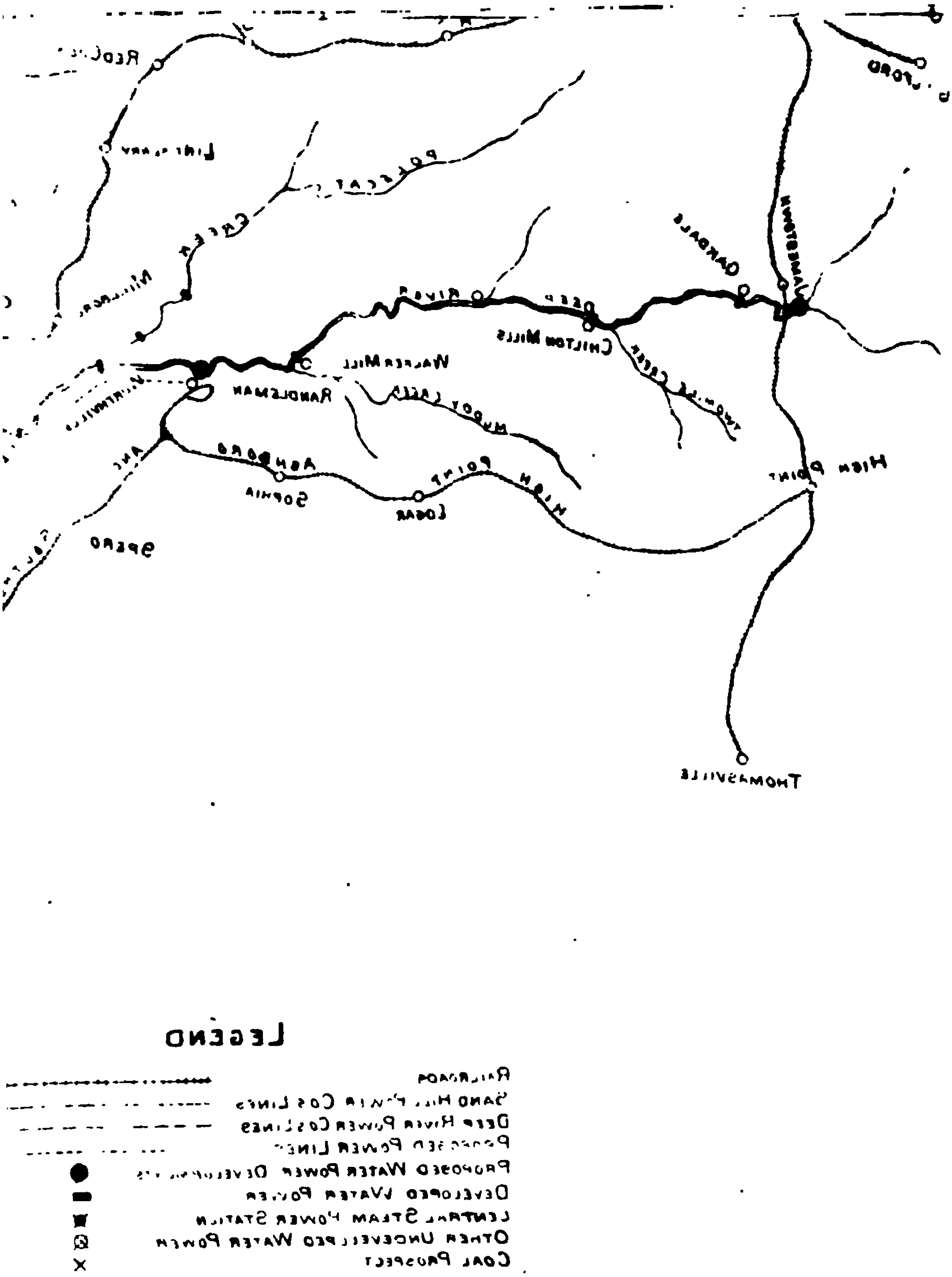
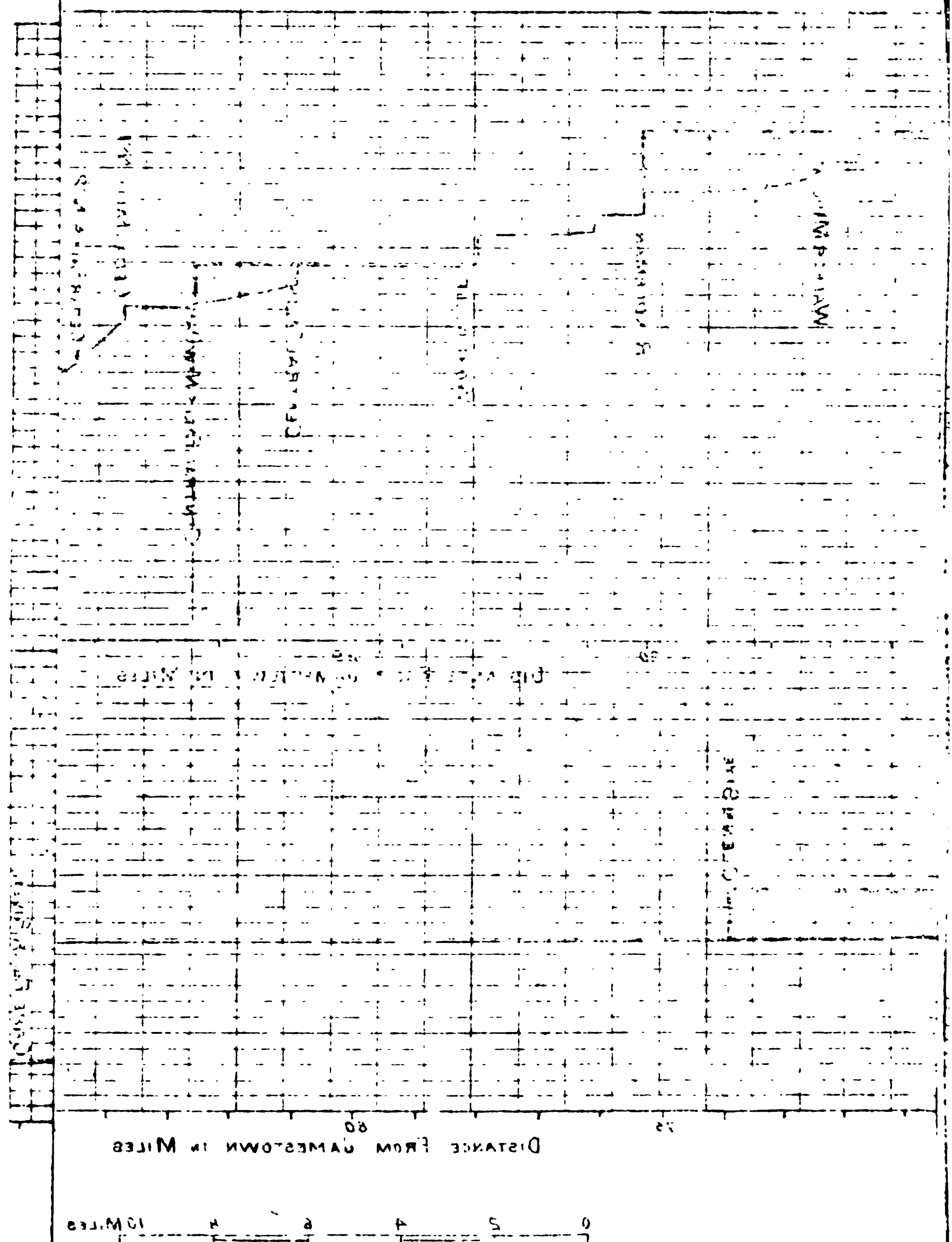


Redding
Liberty
Polecat Creek
Deep River
Walker Mill
Randleman
Muddy Creek
Chilton Mills
Oakdale
Jamestown
Guilford
High Point
Ashboro
Sophia
Logan
Thomasville
LEGEND
Railroads
Sand Hill Power Co's Lines
Deep River Power Co's Lines
Proposed Power Lines
Proposed Water Power Developments
Developed Water Power
Central Steam Power Station
Other Undeveloped Water Power
Coal Prospect


60
75
DISTANCE FROM JAMESTOWN IN MILES
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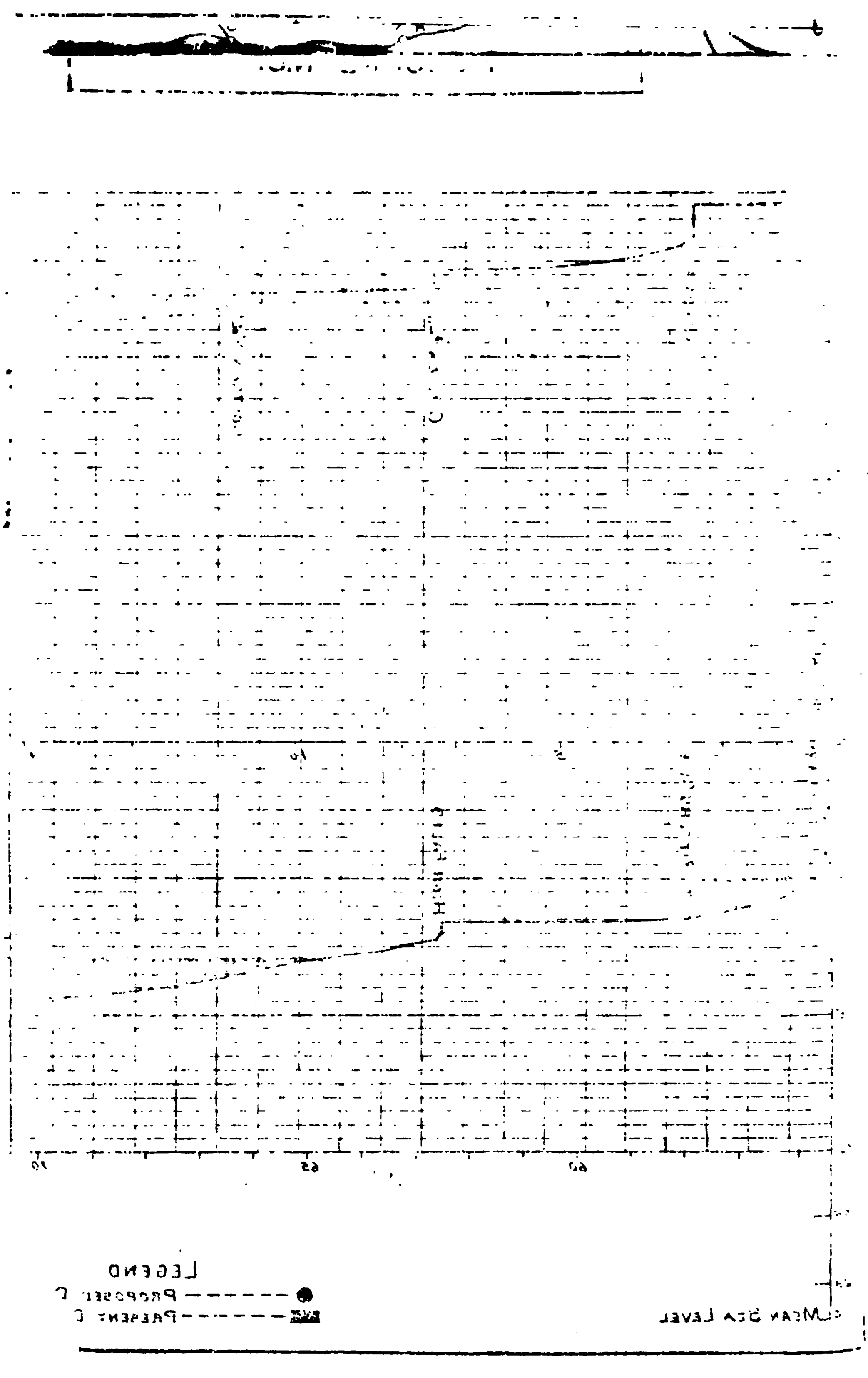
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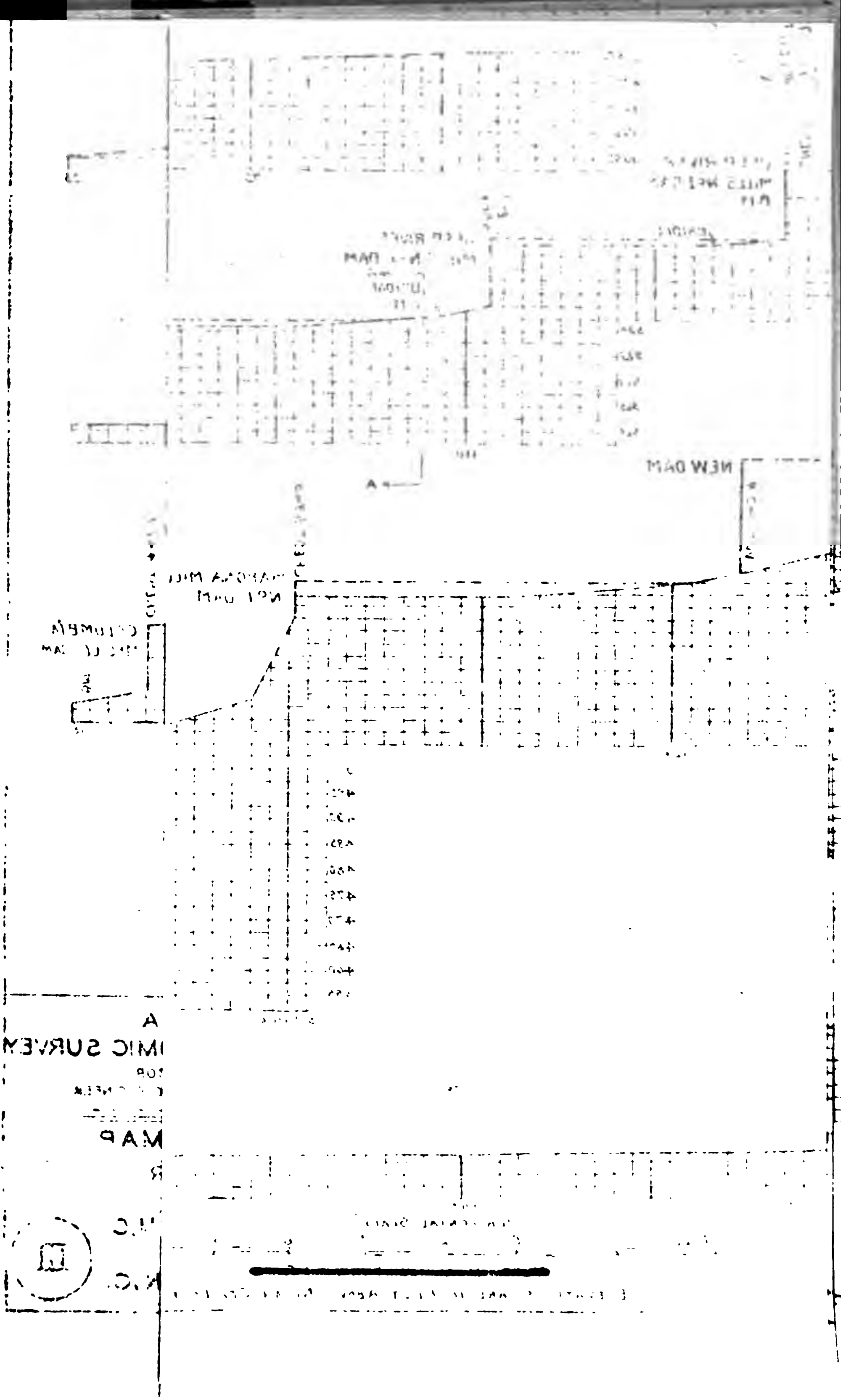
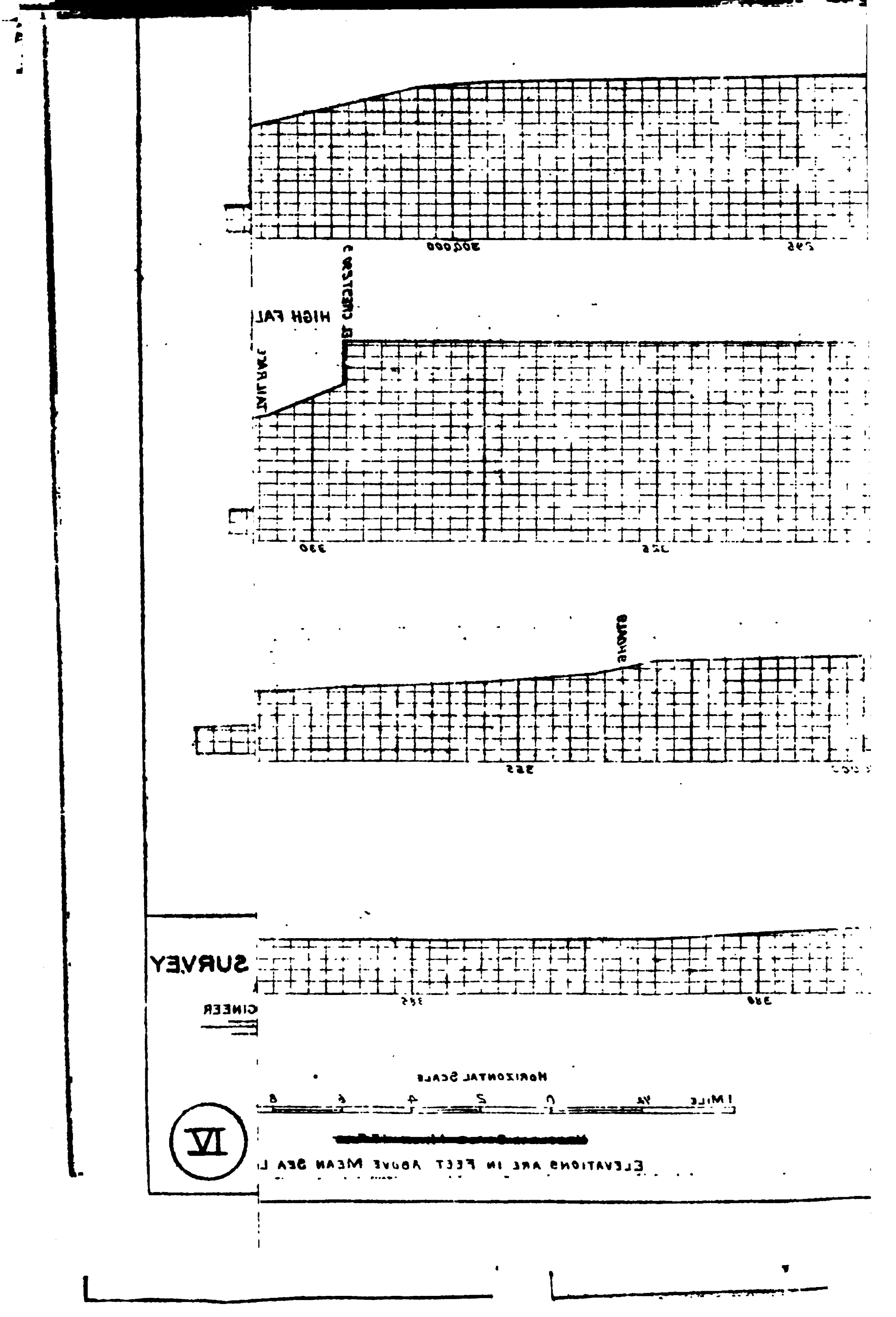
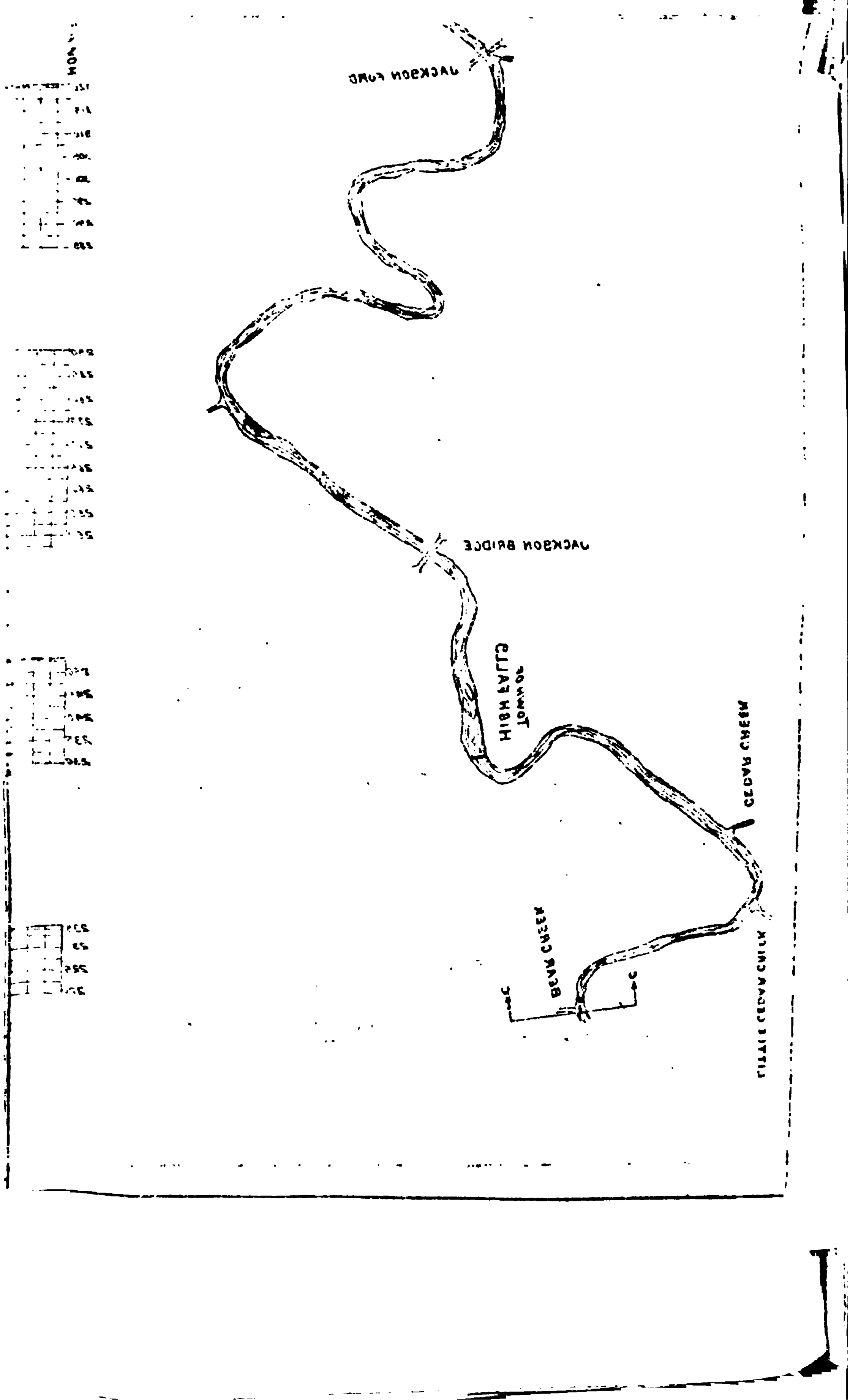
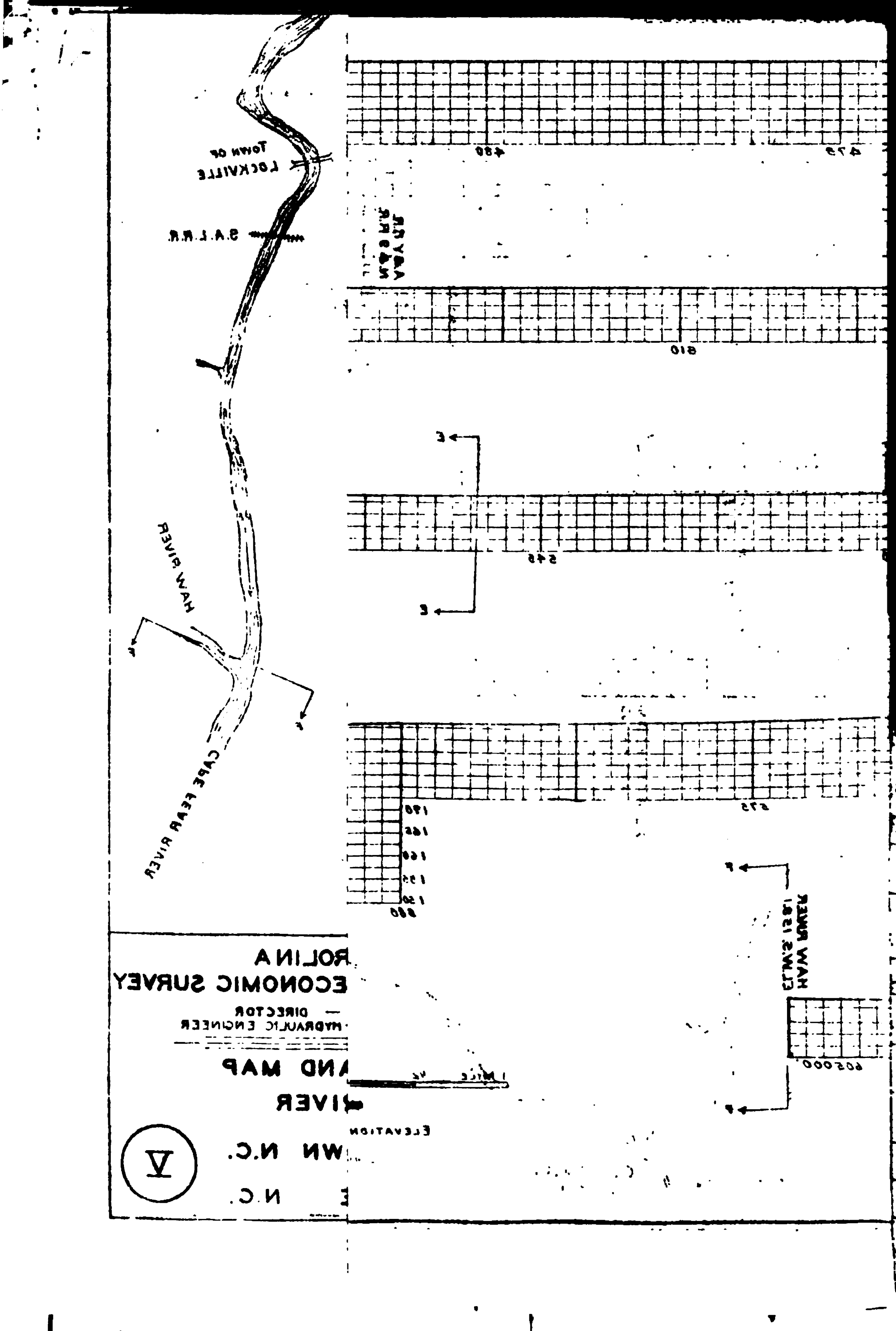
65
60


NEW DAM
COLUMBIA
MIC SURVEY
MAP


HIGH FAL
SHOALS
SURVEY
HORIZONTAL SCALE
ELEVATIONS ARE IN FEET ABOVE MEAN SEA L
VI



JACKSON FORD
JACKSON BRIDGE
TOWN OF
HIGH FALLS
CEDAR CREEK
BEAR CREEK
LITTLE CEDAR CREEK



ROLINA
ECONOMIC SURVEY
— DIRECTOR
HYDRAULIC ENGINEER
AND MAP
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V
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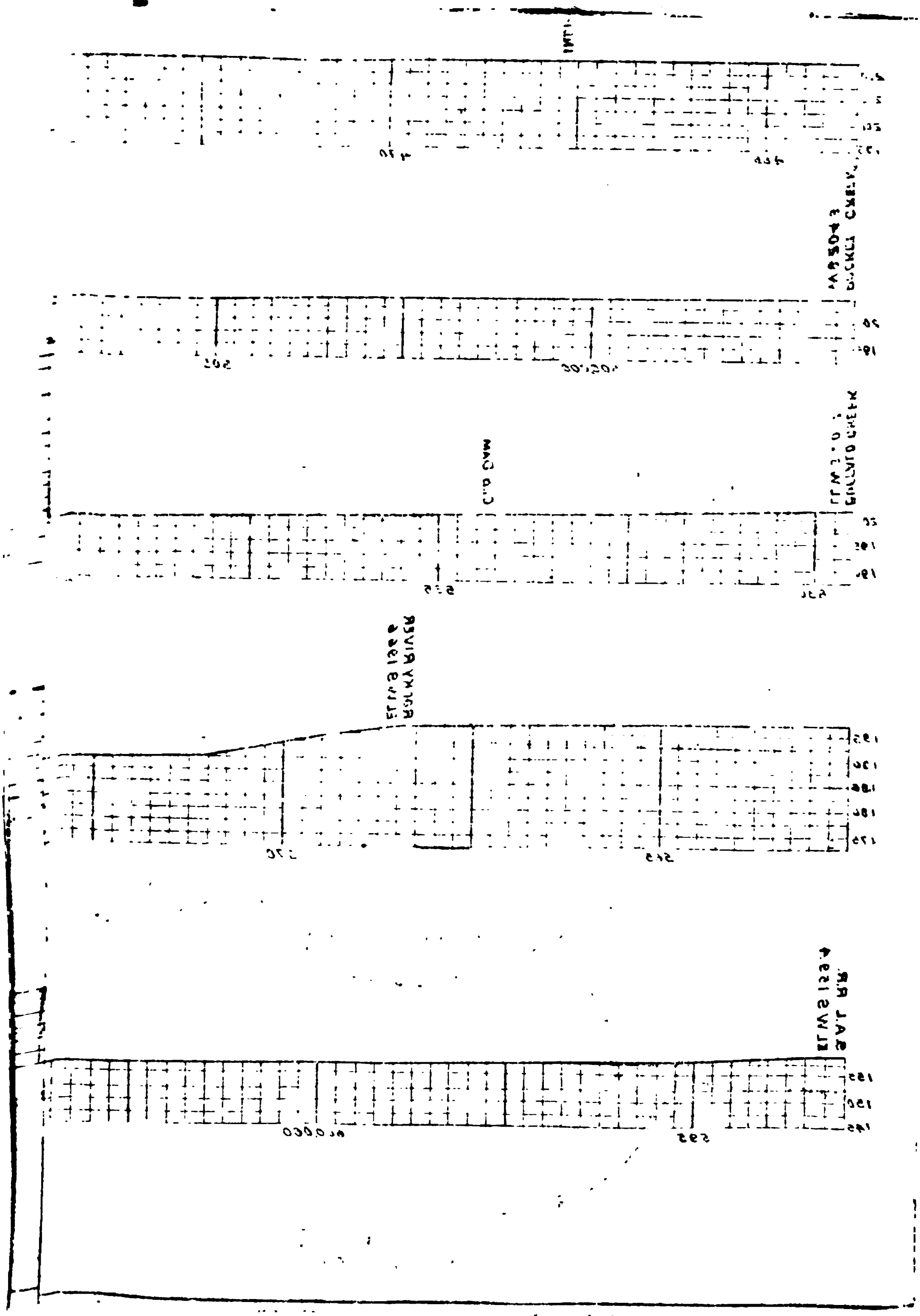
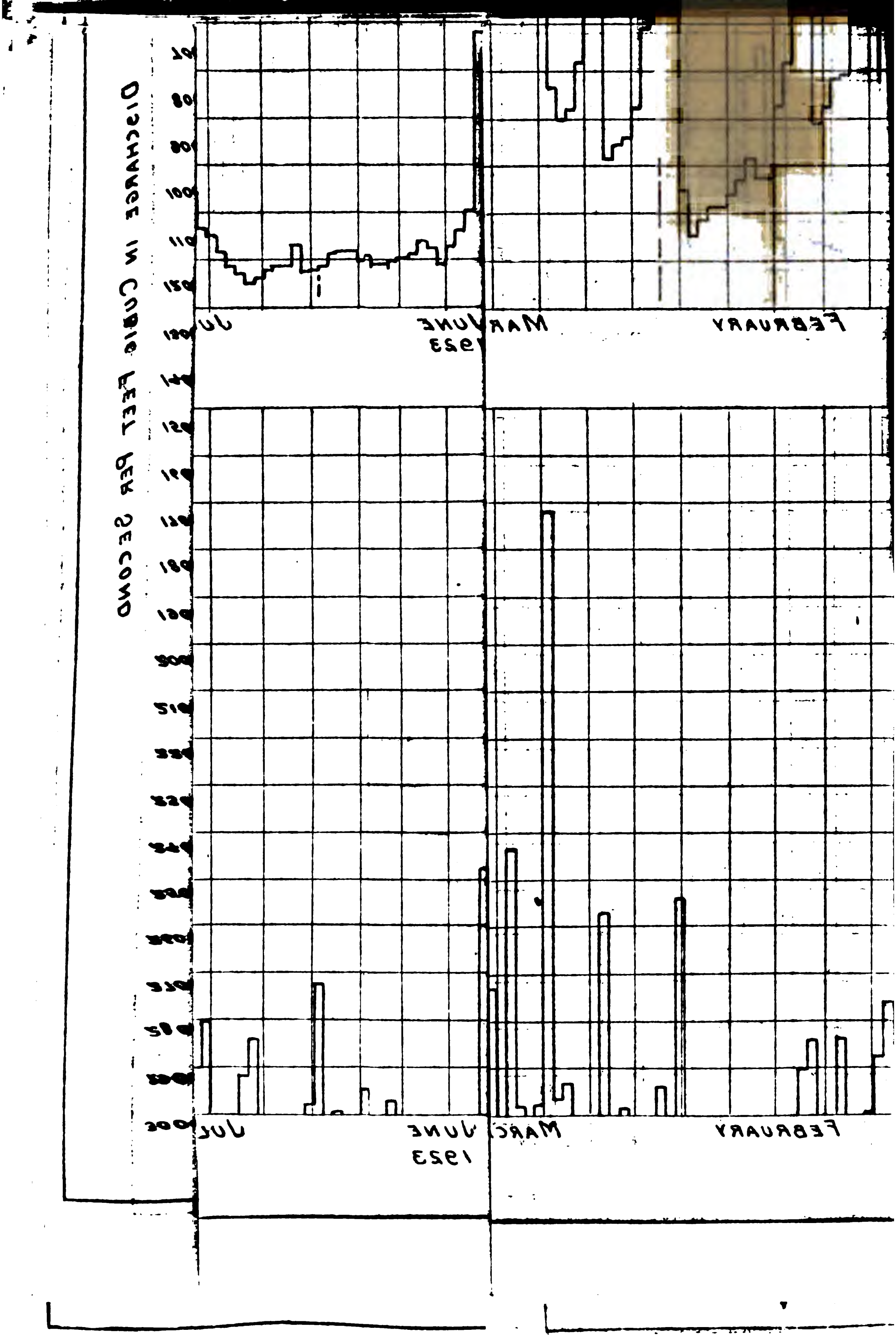
LOCKVILLE
S.A.L.R.R.
HAW RIVER
CAPE FEAR RIVER




DISCHARGE IN CUBIC FEET PER SECOND
JUNE
1923
MAR
FEBRUARY
JUNE
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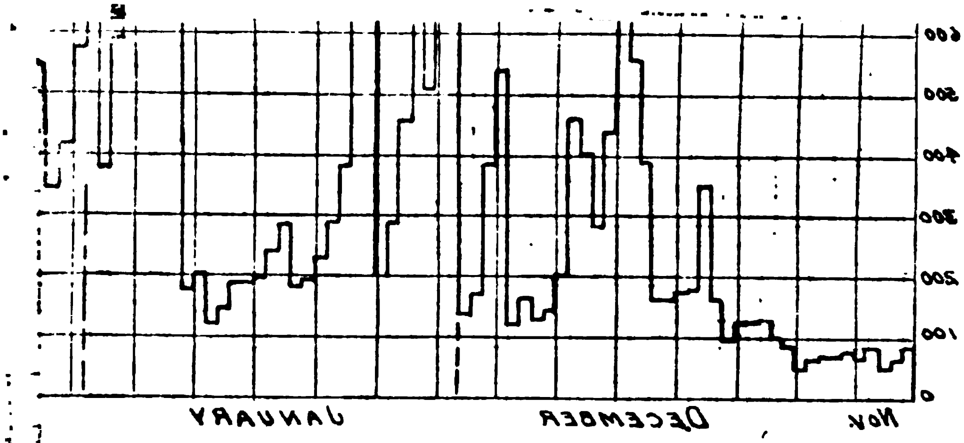
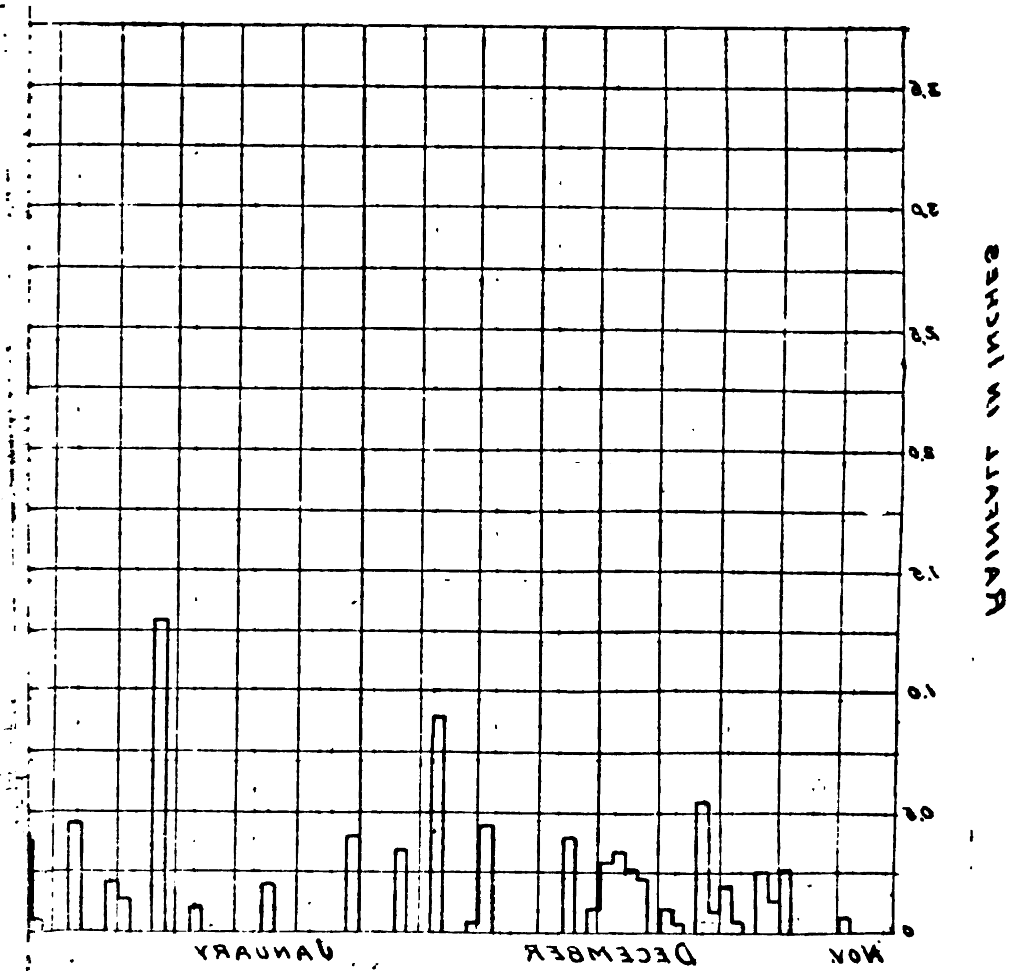

600
500
400
300
200
100
0
JANUARY
DECEMBER
NOV.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RAINFALL IN INCHES
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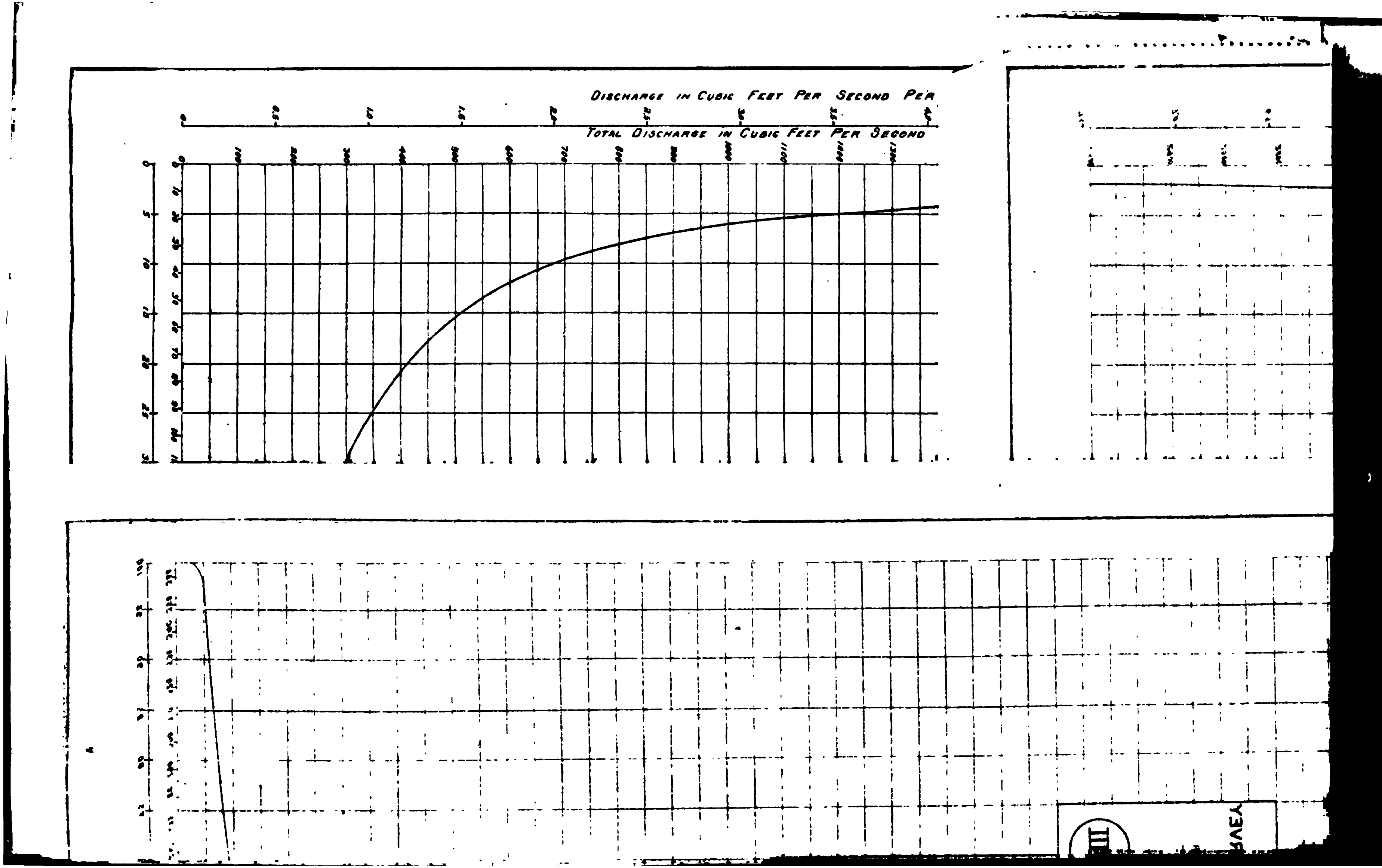

DISCHARGE IN CUBIC FEET PER SECOND PER
TOTAL DISCHARGE IN CUBIC FEET PER SECOND
0
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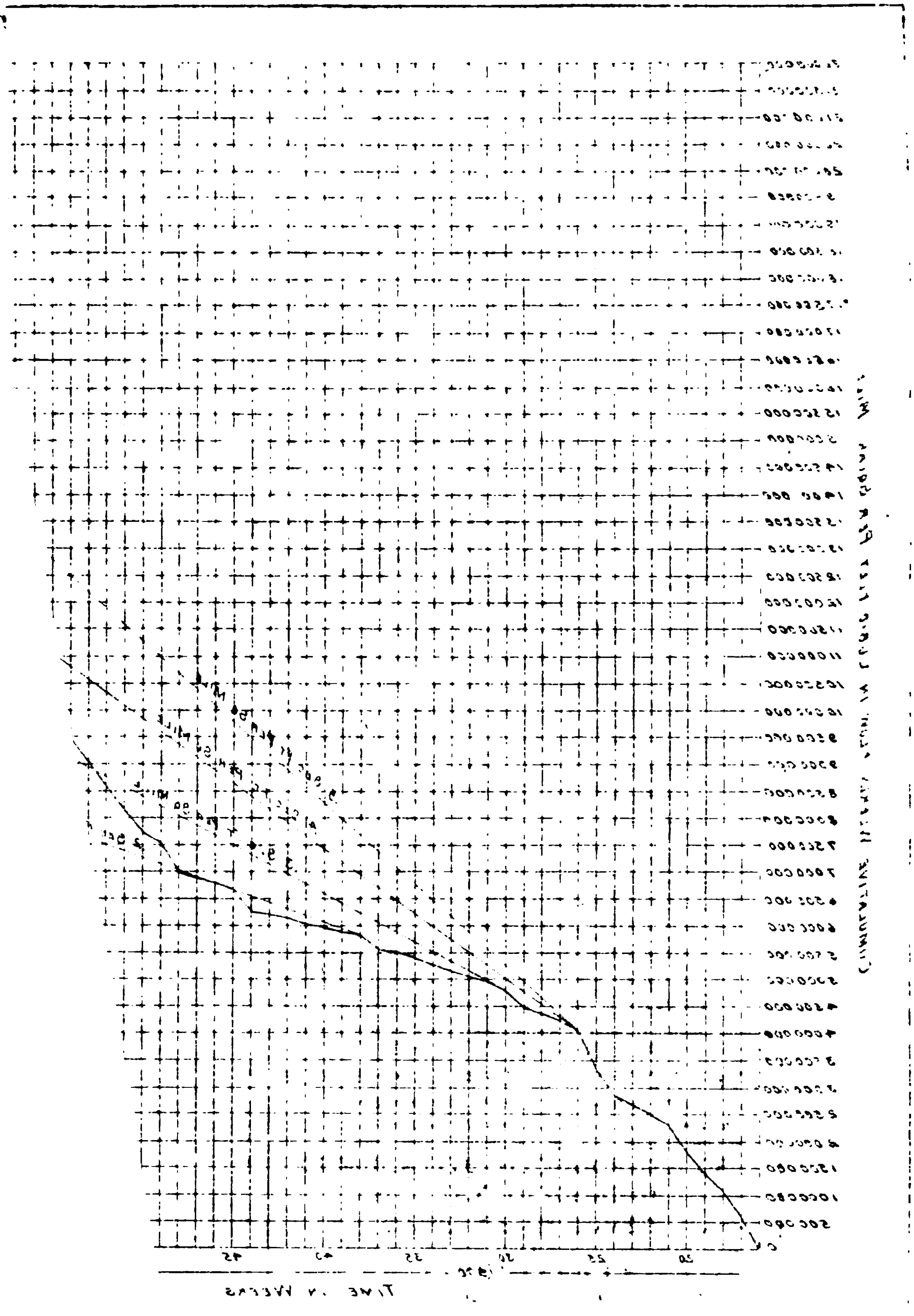
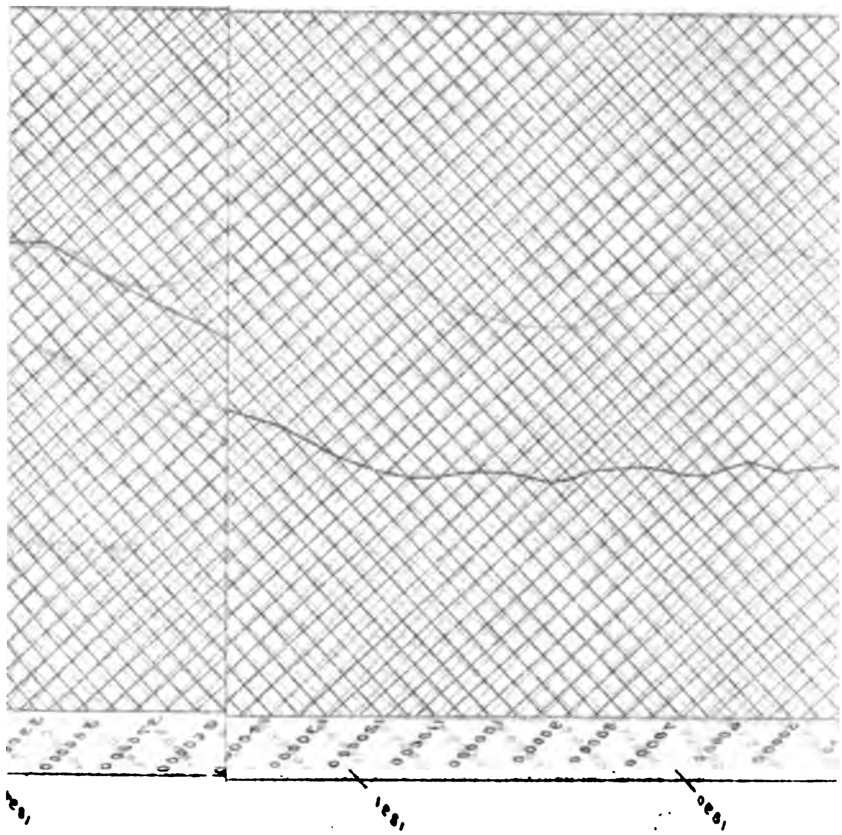
300
400
500
600
700
800
900
1000
1100
1200
1300


TIME IN WEEKS



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NOTE

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